United States
Department of
Agriculture

**Forest
Service**

Eastern Region

and

United States
Department of the
Interior

**Bureau of
Land Management**

Eastern States Office

Draft Environmental Impact Statement

Hardrock Mineral Leasing
Mark Twain National Forest
Missouri

PREPARATION AND PUBLIC REVIEW OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

The Doe Run Corporation holds interest in two mineral lease applications filed with the Bureau of Land Management (Bureau) for development of lead, zinc copper and associated minerals underlying the Mark Twain National Forest, Missouri. In response to the applications, the Forest initiated the preparation of a preliminary environmental assessment (EA), but in October, 1986, prior to completion of the EA, the Forest Service and the Bureau decided to prepare an environmental impact statement. The decision to prepare an environmental impact statement was based on the expansion of the analysis area to encompass anticipated future mineral leasing activities, the fact that mining had not previously occurred in this portion of the Forest and the high degree of public concern.

The EIS has been prepared in accordance with the guidelines established by the Council on Environmental Quality, supplemented by Forest Service and Bureau guidance. The process established by the National Environmental Policy Act, and implementing regulations, is intended to help public officials make decisions that are based on a detailed understanding of the environmental consequences.

The draft EIS has been circulated to Federal, State and local agencies, as well as special interest groups and interested individuals. Public hearings will be conducted at St. Louis, Jefferson City, and Winona, Missouri. The following is a schedule of public hearings:

Tuesday, December 1, 1987	St. Louis, Missouri Missouri Botanical Gardens Ridgeway Center - Shoenberg Auditorium 4344 Shaw 7:00 - 10:00 p.m.
Wednesday, December 2, 1987	Jefferson City, Missouri Hotel Governor Ballroom 200 Madison 7:00 - 10:00 p.m.
Thursday, December 3, 1987	Winona, Missouri Winona High School Gymnasium 7:00 - 10:00 p.m.

In addition, a public comment period will extend to December 24, 1987, for receipt of written comments. Written and oral comments received at the public hearings and additional comments received during the comment period will be used to develop the final EIS tentatively scheduled to be published in April 1988.

Comments or questions regarding this draft EIS should be sent to:

B. Eric Morse, Forest Supervisor
Mark Twain National Forest
401 Fairgrounds Road
Rolla, Missouri 65401

UNITED STATES
DEPARTMENT OF AGRICULTURE
DEPARTMENT OF THE INTERIOR

HARDROCK MINERAL LEASING

MARK TWAIN NATIONAL FOREST, MISSOURI

Draft Environmental Impact Statement
OCTOBER 1987

Prepared by the U.S. Department of Agriculture, Forest Service and the U.S. Department of the Interior, Bureau of Land Management in cooperation with the U.S. Fish and Wildlife Service, National Park Service, U.S. Geological Survey, U.S. Army Corps of Engineers and the Missouri Department of Conservation.

HARDROCK MINERAL LEASING ON THE MARK TWAIN NATIONAL FOREST
CARTER, OREGON AND SHANNON COUNTIES, MISSOURI

Draft Environmental Impact Statement
OCTOBER, 1987

This environmental impact statement was prepared by the U.S. Department of Agriculture, Forest Service and U.S. Department of the Interior, Bureau of Land Management in cooperation with the U.S. Fish and Wildlife Service, National Park Service, U.S. Geological Survey, U.S. Army Corps of Engineers and Missouri Department of Conservation.

ABSTRACT

The environmental impact statement describes the circumstances surrounding its preparation from the issuance of prospecting permits to the submission of two hardrock mineral preference right lease applications (3700 acres) on the Mark Twain National Forest. It outlines the legal requirements governing mineral activity, provides a history of lead mining in Missouri, and describes various mineral-related activities which may occur. Based on comments by the public and Federal land managers, it identifies public issues and management concerns regarding potential mineral activity. It develops five alternatives for mineral leasing based on the issues and concerns. Each alternative is analyzed in detail. These alternatives represent a full range of possible actions from maximum resource protection to maximum mineral resource development. The analysis considers the physical, biological, economic, and social environments of the 119,000 acre study area. The analysis indicates that implementation of an alternative other than no action could result in unavoidable adverse effects to water resources by changing flow patterns and introducing pollutants into the environment; to biological resources by reducing habitat and/or disturbing species; and to visual quality and land character through landscape modification and the introduction of structures. The environmental impact statement has been prepared in collaboration with the Mark Twain National Forest Land and Resource Management Plan. Each alternative has been evaluated in terms of its consistency with the Plan. The alternative selected must be consistent with the Plan or the Plan must be amended. Alternative D: Modified Forest Plan (visual quality) has been identified as the Preferred Alternative.

COMMENTS ON DRAFT EIS

Oral and written comments may be provided at any of the three scheduled public hearings. Written comments may be submitted to the Forest Supervisor, Mark Twain National Forest, 401 Fairgrounds Road, Rolla, Missouri 65401. All comments must be received by December 24, 1987.

FURTHER INFORMATION

For further information, contact the following:

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HARDROCK MINERAL LEASING
MARK TWAIN NATIONAL FOREST, MISSOURI

EXECUTIVE SUMMARY

Preliminary geologic investigations carried out in the study area in the late 1970's and early 1980's have revealed conditions indicating a potential for the occurrence of orebodies containing lead and associated metals. If the Forest Service and Bureau of Land Management (Bureau) decide to issue mineral leases, exploration will continue and, if lead resources are found in economic quantities, production will result. Although there is no assurance of mineable reserves, the study area has been identified as the most likely area to provide future domestic supplies of lead.

Alternative D: Modified Forest Plan (visual quality) has been identified as the Preferred Alternative.

BACKGROUND

The lands currently under lease application as well as all other Federal lands (119,000 acres) within the 157,000 acre study area have been acquired by the Forest Service under the authority of the Weeks Law. Such acquired lands are generally open to mineral exploration, development and production. In addition to the Weeks Law, mineral development on acquired lands is further guided by Section 402 of Reorganization Plan No. 3 which transferred the minerals management responsibilities of the Secretary of Agriculture to the Secretary of the Interior. As a condition of this transfer, the Secretary of Agriculture has either power to veto mineral development in order to protect National Forest System lands, or to consent to mineral activities, adding any necessary conditions to protect the lands.

Lead mining has occurred in southeastern Missouri since 1720 with major production commencing in 1864 by the St. Joseph Lead Company (St. Joe). Mining operations were conducted at or near Bonne Terre, Missouri until 1972 when the last mine in the "old lead belt" ceased operations. As early as 1943, when it was apparent that the reserves were approaching depletion, St. Joe initiated an extensive exploration program in search of new deposits. In 1955, a mineable deposit was discovered 30 miles west of the Old Lead Belt within the boundaries of the Mark Twain National Forest. The Viburnum Trend as this most recent mining district is called contains the largest domestic lead reserves currently known, producing 90 percent of U.S. supplies. It is also the largest lead mining area in the world. At present, seven mines are producing with two mines temporarily shut down. The Viburnum Trend is expected to produce at present levels to the year 2000 at which time will rapidly decline. Because of the relatively short remaining field life, lead mining companies have begun extensive lead exploration programs. The most promising area identified so far in the United States is directly south of the Viburnum Trend in the Winona-Doniphan-Van Buren Ranger Districts of the Mark Twain National Forest. A substantial amount of exploratory drilling has occurred on Federal minerals under Prospecting permits issued by the Bureau. Approximately 250 core holes have been drilled during the past eight years. All of the exploration conducted in this region of the Forest has been within the study area.

As a result of such exploration activities, a few core holes have encountered mineralization in sufficient thickness and grade to indicate the presence of an orebody. The Preference Right Lease Applications submitted by U.S. Steel Corporation (subsequently acquired by Doe Run) for Prospecting Permits ES-19219 and ES-19220 were initiated because of the presence of pay holes. In addition to these permits, there are ten existing prospecting permits and one pending agency review. Depending upon geologic data resulting from exploration, there may be additional lease applications in the future.

PURPOSE AND NEED FOR ACTION

The Doe Run Corporation holds interest in two mineral lease applications filed with the Bureau for development and production of lead, zinc and associated metals underlying the Mark Twain National Forest, Missouri.

Upon receipt of the lease applications, the Forest Service prepared a preliminary environmental assessment. However, in October 1986, prior to completion, the Forest Service and Bureau determined that the analysis area should be enlarged to include these and future lease applications and that an environmental impact statement should be prepared to assess the potential impacts of mineral-related activities. Further, it was decided that the analysis would be conducted jointly by the two agencies. The decision to prepare an environmental impact statement was based on the expansion of the analysis area to encompass anticipated future mineral activities, the fact that mining had not previously occurred in this portion of the Forest, and the high degree of public concern.

There are two decisions to be made regarding hardrock mineral leasing within the study area. These decisions are whether or not to consent to and issue competitive and non-competitive mineral leases for all Federally-owned minerals within the study area and, if so, under what terms and conditions. The Forest Service must determine whether or not mineral leasing is consistent with the purposes for which the lands were acquired and are being administered. If such activities are consistent, the Forest Service would consent to lease issuance and provide the Bureau with any conditions necessary to protect resource values and uses. If the Forest Service provides consent, the Bureau must decide whether or not to issue a lease and, if so, the terms and conditions to be applied to the lease. Any conditions provided by the Forest Service must be included in the lease.

STUDY AREA

The Forest is currently managed under the Mark Twain National Forest Land and Resource Management Plan which outlines a 10 to 15 year strategy to realize a "desired future forest condition." The Plan specifies management prescriptions and standards to achieve this future condition. These standards define specific practices, activities or mitigation measures to ensure attainment of the objectives specified by the various management prescriptions. Proposals to develop and produce Federal minerals underlying National Forest System lands will be reviewed for consistency with the Plan. The study area includes four management prescriptions. These prescriptions and their accompanying standards provide the framework under which mineral leasing may occur.

The study area is located in southcentral Missouri in Shannon, Oregon an Carter Counties, about 120 miles southwest of St. Louis and 100 miles east of Springfield. The area includes approximately 119,000 acres of National Forest System Lands and federally- owned minerals administered by the Mark Twain National Forest and Bureau, respectively. Local communities adjacent to the area include Winona, Alton, Birch Tree, Greer, Fremont, Van Buren, Wilderness, Thomasville and Doniphan.

The area is bordered on the south by the Eleven Point National Scenic River, to the east by the Ozark National Scenic Riverways and to the southeast by the Irish Wilderness. Characterized by well developed karst terrain and rolling hills, the area is dissected by numerous streams with major drainages provided by the Eleven Point and Current Rivers. These rivers and their tributaries have cut v-shaped valleys hundreds of feet deep. Some ridge tops are broad, but the majority are narrow. Slopes are moderate to steep. Elevations range from 500 feet along the Eleven Point River to 1,080 feet in the northwest corner. The area is densely vegetated with hardwood and pine forests providing habitat for numerous plant, animal and fish species several of which are threatened or endangered.

As of July, 1985, population of the region (Butler, Carter, Howell, Oregon, Ripley and Shannon Counties) was estimated to be nearly 105,000. Although the population grew in the 1970's, the rate of increase slowed considerably between 1980 to 1985. Over the past 15 years, population in Carter County has grown most rapidly, while Oregon County has had the slowest growth rate of the region.

Historically, wood products manufacturing has been extremely important to the region. In addition to wood products, there is agricultural related employment in meat packing, poultry dressing and cereal and pet food production. There is also the production of apparel, trucks, electric motors and fiberglass boats.

The region has long been a popular recreation district for residents and non-residents. This includes fishing, hunting, camping, floating and picnicking. This also influences service jobs such as canoe rentals, lodging, sporting goods, restaurants, grocery stores and gasoline stations.

PUBLIC INVOLVEMENT AND IDENTIFICATION OF ISSUES

Due to the decision to prepare an environmental impact statement, the Forest Service and Bureau conducted "scoping" meetings to identify issues. Two scoping meetings were held, one in Jefferson City, December 10, 1986, and the other in Winona, December 11, 1986. In addition, Federal, State, and local agency meetings were held in the same cities, prior to the public meetings. The information obtained during the scoping process has been used to guide the preparation of the EIS and will be considered fully in arriving at a decision.

As a result of comments received in response to the environmental assessment and the scoping process, the EIS team has identified public issues and management concerns. The issues consist of water; land character; jobs, economy and lifestyle; threatened and endangered species; lead market; land use purpose; and areas of national significance. The following is a summary of each public issues.

Water

The public expressed concerns that mining would degrade water resources creating hazards which would affect public health, safety, wildlife, tourism and the quality of Ozark life.

Land Character

The public expressed the concern that mineral activities would unacceptably change the lifestyle and experiences of the residents and visitors to the study area. The land provides an abundance of natural resources in a rugged, remote and scenic setting. The quality of life is often measured by the presence of these natural resources.

Jobs, Economy and Lifestyle

Many individuals expressed considerable interest for additional jobs and income in the area. They also expressed concerns that jobs and income related to mining would be of temporary duration and would effect local lifestyles and other industries, including recreation and tourism.

Threatened and Endangered Species

The public voiced concerns that mineral activities would adversely impact habitats and populations of wildlife and plant species. Many of these species are Federally or State-listed threatened or endangered species.

Lead Market

The public speculated on current and anticipated future lead market conditions. They questioned the need for additional lead sources and if it was economically mineable. Conversely, some comments defined the need for additional lead sources to assure for a stable long term supply.

Land Use Purpose

The public stated concerns that mineral development and production is not consistent with the purposes for which National Forest lands were acquired. Mineral activities would either preclude the use and enjoyment of other National Forest resources, or that the Forest Service and the Bureau would not exercise their authority to adequately protect such resources.

Areas of National Significance

Individuals are concerned that mining activities could adversely affect the congressionally designated area comprised of the Eleven Point National Scenic River, Ozark National Scenic Riverways, Irish Wilderness and Excluded Lands; administratively designated Cupola Pond; and other designated natural, scenic or geologic areas including Greer Springs.

The management concerns consist of questions regarding (1) compatibility of mining activities with the Forest Plans and (2) availability of sufficient Federal lands for leasing to ensure a continued flow of lead and associated metals.

POTENTIAL MINERAL ACTIVITIES

Because a lease conveys the right to develop and produce Federal minerals, this analysis considers the possible environmental effects of a full range of mineral activities. These activities range from a few exploration holes to full area development similar to the Viburnum Trend. The EIS considers the effects over the entire study area, not just the lease current application areas. In order to assess the potential impacts of such activities, it was necessary to establish hypothetical "scenarios" to approximate the levels and types of activities which may occur in the event one or more leases are issued.

Three possible levels (scenarios) of mineral development were identified. The lowest level of development referred to as "exploration scenario" would entail exploration drilling only. The second level of development referred to as the "low development scenario" would entail exploration drilling and development of one mine. The design of the hypothetical mine is based on a typical Viburnum Trend mine. The third, or highest level of mineral development referred to as the "high development scenario" would entail a Viburnum Trend-scale mining district consisting of eight mines. It has been estimated that the exploration scenario would employ workers and result in the surface disturbance of 30 acres of land; the low development scenario would employ 170 workers and disturb 451 acres of surface lands; and the high development scenario would employ 1,360 workers and disturb 3,335 acres of land.

FORMULATION OF ALTERNATIVES

In response to the issues and concerns, several alternatives were established to represent the full range of actions available to the decisionmaker. These alternatives range from maximum resource protection to maximum development of mineral resources.

Alternative A provides maximum resource protection for non-mineral resources by prohibiting mineral development.

Alternative B permits maximum mineral development by allowing standard mining practices currently used in the Viburnum Trend. This alternative protects water quality and the Eleven Point Scenic River corridor.

Alternative C permits a level of mineral development consistent with the current Forest Plan. This alternative protects water quality, areas of national significance and threatened and endangered species and species habitat. Further, it minimizes risk of impact to land character and visual quality by limiting the amount of land available for mineral development. Transmission corridors and tailings impoundments would be prohibited on nearly 80 percent of the study area while haul roads and mine/mill facilities would be prohibited on 70 percent of the area. In addition, road construction would be restricted on over 11,300 acres included within 6.2 management areas.

Alternative D increases land available for mineral activities over that of Alternative C, while protecting water quality, area of national significance and threatened and endangered species. Visual quality standards would be changed to permit mineral activities over a larger percentage of the area. Tailings impoundments would be prohibited on 60 percent of the study area, transmission corridors prohibited on 52 percent of the area, mine/mill facilities on 50 percent and haul roads 39 percent.

Alternative E further increases the amount of land available for mineral development by changing the visual quality standards as in Alternative D and by changing the 11,300 acre 6.2 management area to a 3.4 management area. Tailings impoundments would be prohibited on 57 percent of the study area, transmission corridors prohibited on 49 percent of the area, mine/mill facilities on 47 percent and haul roads 36 percent.

ENVIRONMENTAL CONSEQUENCES

The impact assessment indicates that without mitigation environmental consequences from permitting mineral development in the study area could result in long-term adverse effects to water resources through a risk of tailings impoundment failure or chronic leakage; land character through an accelerated change to the landscape caused by alteration of existing land patterns and uses; and potential effects to threatened and endangered species through a risk of degradation. The presence of infrastructure supporting mineral development could adversely affect the Ozark lifestyle.

The majority of adverse effects would be minimized or eliminated through carefully applied mitigating measures, using the lessons learned and technology acquired from existing development in the Viburnum Trend and previous activities in the Old Lead Belt. The evidence generated during years of mining on the Viburnum Trend indicate the majority of potential impacts may be eliminated or reduced. In addition, the impact assessment indicates that some of the alternatives effect land availability for mineral development which may effect future domestic lead supplies.

Eight issues and two concerns were identified during environmental assessment review scoping which were analyzed in the EIS. Four of these have been determined to be critical to lease decision. These are the potential effects of mineral activities on water resources, land character and threatened and endangered species, and the effects of the lease decision on lead market conditions.

The other issues though important did not appear to influence the future decision whether or not to lease. Further, based on experience in the Viburnum Trend and other areas of the Forest, it was determined that potential impacts from these activities would be successfully mitigated.

Nine different mitigation measures were identified to reduce or eliminate, they include:

(1) Design and locate facilities to reduce disturbance and facilitate reclamation;

(2) Design and locate facilities to allow natural surface and groundwater flows;

(3) Reclamation plans will include provisions for immediate stabilization and attainment of Forest Plan objectives;

(4) Control of wind blown contaminants;

(5) Control of point source pollutants;

(6) Tailings disposal method must meet Missouri Department of Natural Resources "no discharge" requirement;

(7) Use of noise abatement techniques and practices;

(8) Impoundment operation and maintenance plan; and

(9) Use of environmental awareness and education programs.

The implementation of some of the alternatives would require an amendment to the Forest Plan.

Alternatives B, C, D and E may permit full mineral development (up to an estimated 3400 acres), however, the alternatives vary by the amount and location of land available for surface occupance. Table 1 summarizes land availability by alternative.

TABLE 1
SUMMARY OF LAND AVAILABILITY BY ALTERNATIVE

Alternative	% Acreage Available for Occupancy	Forest Plan Amendment
A	0	No
B	90	Major Revision
C	30	No
D	30	Revise visual objectives
E	51	Revise visual objectives and reclassify 6.2 management area

Source: USDA-Forest Service, 1987

Water Resources

The greatest risk to water resources and water-related uses from mineral activities is posed by the disposal of tailings, specifically chronic leakage from or failure of an impoundment. This could result in tailings escaping into the groundwater system. This in turn could clog the system resulting in altered flows, contaminated springs, dryed-up or flooded caves, or reduce the quality of recreation on the Eleven Point or Current Rivers. This would directly affect water-related recreation activities as well as terrestrial, aquatic and cave wildlife (including threatened and endangered species).

These effects are very unlikely under any alternative because the construction and use of tailings impoundments will be strictly controlled in the study area. If leases are issued each will contain the following stipulation to ensure the adequate protection of water resources:

Mine tailings impoundments will not be permitted within the lease area unless additional studies conclusively show that such facilities can be constructed in an environmentally sound manner. Any subsequent decision to approve tailings impoundments will be made by the Missouri Department of Natural Resources, Forest Service and the Bureau of Land Management. This decision will be based on study findings and the preparation of appropriate environmental documentation in compliance with the National Environmental Policy Act.

Prior to the possible siting of tailings impoundments, detailed geotechnical characterization studies would eliminate high risk locations. Further, the stipulation could involve the use of alternative methods of tailings disposal, such as stope backfilling, impoundment liners, below-grade disposal, thickened discharge and off-site disposal. These methods would reduce or eliminate the risk of accidental tailings releases to the environment, although other adverse effects may occur from development of roads, pipelines or tailings piles.

However, regardless of the method of disposal the risks to water resources are limited to the effects of sediment loading from the accidental release of tailings. Very little if any heavy metal or milling reagents would be in the tailings because current State water quality standards restrict effluent levels. Further, and most importantly, research in the Viburnum Trend has found that dissolved metals are securely bound by clay particles and are not available for biological uptake. Therefore, the greatest risk to both water quality and quantity that would result from either chronic leakage or a catastrophic collapse of an impoundment, is the physical impact of the tailings.

If a failure occurred, it could load both the surface and subsurface systems with thousands of yards of tailings. This could choke stream bottoms, change surface channels and alter groundwater flows. Such an event would directly affect water-related recreation activities as well as terrestrial, aquatic and cave wildlife (including numerous threatened and endangered species). The other potential impacts such as sedimentation from clearing activities or drilling effluent disposal can be mitigated by proper design, location, construction and operation of facilities.

In addition to site investigations, facility design and locating proper facility operation and maintenance would further reduce the risk of accidental releases from an impoundment.

In summary, site investigations would eliminate high risk areas; facility design alternatives would reduce the risk of accidental releases; existing State water quality standards would reduce the level of heavy metals and milling reagents allowed in tailings water; and operational standards and monitoring would ensure facility integrity. In the event heavy metals or milling reagents are accidentally released, research indicates that adverse effects would be minimal.

Land Character

Mineral activities would affect the area's land character in two ways. The most obvious effects would result from changes to landscape. Clearings would be made for roads, powerlines, mine/mill facilities and drill sites. Land would be occupied for tailings impoundments and structures would be erected for milling. In total, over 3,000 acres could be occupied. The impact on land character would depend in part on the proximity of these activities to areas of use. This varies by alternative. Alternative B would result in the greatest potential impact to the landscape because activities would be permitted over much of the area. Under Alternative C nearly 80 percent of the area would be off limits for tailings impoundments an powerlines, as well as over 70 percent off limits for haul roads and mine/mill facilities. There would be several location and design mitigation measures to reduce or eliminate potential impacts to the landscape under Alternatives C, D and E. Under Alternatives D and E these percentages drop but still prohibit activities on nearly 50 percent of the area.

A more subtle change to land character could occur as mining affects the use patterns of residents and visitors. Again depending upon location and magnitude of other effects, mining could change the way people use the land. People could recreate in different area because of the proximity of mineral to an area. Mining could affect wildlife patterns which in turn could affect hunter use patterns. Mining could affect water affecting recreation and fishing use. Most importantly however mining could affect the way people view the area. For some people the area will lose its "Ozark" charm.

In addition to location and design, noise abatement mitigation and environmental education mitigation could reduce some of the impacts on land character for some people. For others there is no acceptable mitigation except to prohibit all mineral-related activities.

Threatened and Endangered Species

The potential effects to Federal and State-listed species from mineral activities could result from habitat destruction, alteration or disturbance, or from possible changes in water quantity or quality. Habitat could be destroyed or altered by the clearing for and construction of mineral-related facilities. Disturbance to listed species from noise, activity, or increased access could increase competition among individuals and cause physiological changes decreasing the ability for adjustment to other environmental factors. Both habitat change and disturbance could reduce some populations. If water quality or quantity were changed as a result of mineral

activities, some aquatic species could decrease and other, less desirable species, might increase. Properly processed tailings materials exhibit chemical profiles which in all probability would remain sequestered from biological assimilation. In the event unprocessed (or improperly processed) tailings are released, detrimental up take of heavy metals could occur. It is possible that acute toxicity could occur but it is most likely that chronic effects would evolve resulting in genetic disruptions, eventual heavy metal poisoning in the form of nervous disorders and contaminated flesh of game fish. In summary, the effects of mineral-related activities on individual species could range from undetectable to the death of many individuals, although such an event is unlikely.

Mitigating measures which would decrease the potential for the occurrence of adverse effects include water stipulation, various no surface occupancy stipulations, field surveys conducted prior to surface disturbing activities, and Eleven Point River zone restrictions on exploration and development. The water stipulation and State water quality standards greatly reduce the risk of adverse effects resulting from the accidental release of tailings. Field surveys would identify the location of threatened or endangered species and their habitat to incorporate use restrictions. Surface and river zone restrictions based on the location of species or habitat would greatly reduce the occurrence of an interaction between protected species and mineral-related activities.

A biological assessment has been prepared analyzing potential effects to Federally-listed threatened and endangered species pursuant to the Endangered Species Act, as amended (Appendix 9). This assessment has been provided to the U.S. Fish and Wildlife Service for review. An opinion of this assessment will be fully considered prior to a final decision.

Lead Market

A decision to permit mineral leasing within the study area would positively affect the domestic lead mining industry. The establishment of land availability throughout the area under Alternative B would allow for the systematic delineation of future lead reserves as existing production in the Viburnum Trend continues. This would permit the mining industry to obtain the necessary approvals to establish a new mining district concurrent with the decline of existing production. Alternative B would best accommodate such a progression of events because the majority of lands within the study area would be available for full mineral development.

Under the other development alternatives (C, D and E), surface areas available for mineral-related activities become progressively smaller with Alternative C permitting the least amount. Because the area has yet to be fully-delineated geologically, alternatives allowing for the greatest amount of land area availability without surface use restrictions will greatly enhance the probability of establishing future lead reserves. Conversely, alternatives which are more restrictive place increased economic burdens on mineral operations which tend to preclude marginal deposits.

Alternative A would not permit any mineral development in the study area. This would preclude the potential production of lead and associated metals from one of the most promising areas in the country. The decision to deny leasing and subsequent development would forego potential future local jobs and income, returns to the U.S. Treasury and payments to affected counties.

A decision to implement Alternative A would eliminate the availability of an area characterized as having the highest potential for future domestic lead reserves. This could affect long-term domestic lead supplies and the nation's existing infrastructure to process metals. Further, this would require greater future dependence on foreign sources of lead.

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ACRONYMS AND ABBREVIATIONS

ATV	All terrain vehicle
AUM	Animal Unit Month
CFR	Code of Federal Regulations
CSR	Code pf State (Missouri Regulations
CFS	Cubic feet per second
EA	Environmental Analysis
EIS	Environmental Impact Statement
EO	Executive Order
EVC	Existing Visual Conditions
FR	Federal Register
STAT	Federal Statute at Large
IMPLAN	Impact of Planning
KV	Killivolt
L	Liter
LME	London Metal Exchange
MG	Milligram
MSHA	Mine Safety and Health Administration
DNR	Missouri Department of Natural Resources
MMBF	One billion board feet
MM	One million
M	One thousand
MAUM	One thousand animal unit months
MRVD	One thousand recreation visitor days
MWFUD	One thousand wildlife and Fish user days
ONSR	Ozark National Scenic Riverways
PPB	Parts Per Billion
PPM	Parts Per Million
PILT	Payment In Lieu of Taxes
PAOT	Persons-at-one-time
P	Primitive
ROS	Recreation Opportunity Spectrum
RVD	Recreation Visitor Day
RSMO	Regulation of the State of Missouri
RN	Roaded Natural
R	Rural
SPM	Semi-Primitive Motorized
SPNM	Semi-Primitive Nonmotorized
MBF	Thousand board feet
U	Urban
VMS	Visual Management System
VQO	Visual Quality Objective
WFUD	Wildlife and Fish User Day

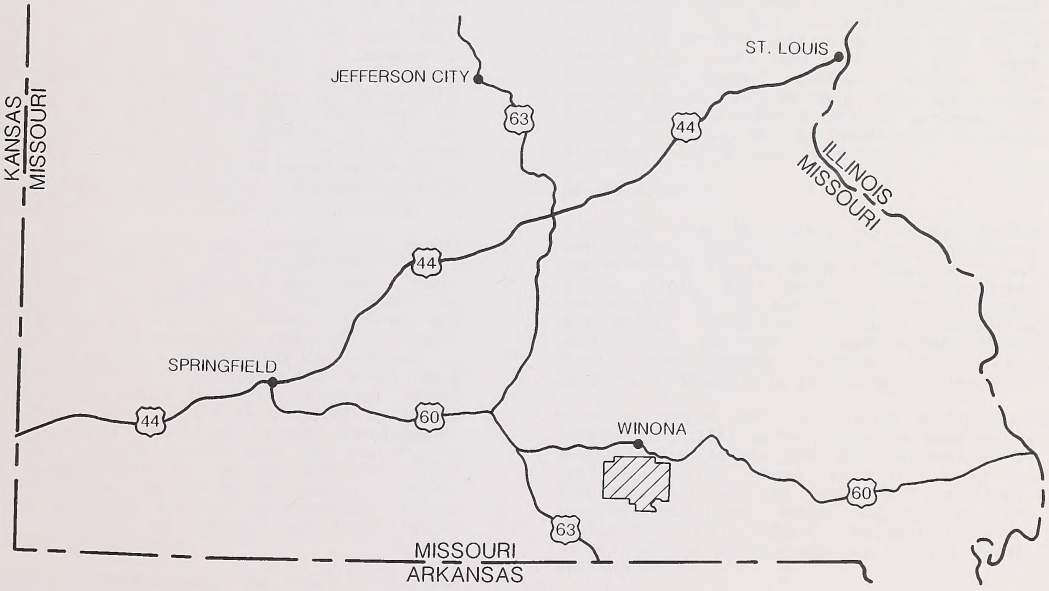


Figure 1: LOCATION MAP OF EIS STUDY AREA

CHAPTER ONE

PURPOSE AND NEED

INTRODUCTION

This chapter describes the purpose and need for the preparation of this environmental impact statement (EIS). It outlines the lease applications and describes the study area boundaries. The chapter then focuses on the decisions to be made and the legal framework within which lease issuance could occur. Next, the chapter describes the scoping process defining the public issues and management concerns associated with leasing. Finally the chapter summarizes the history of lead mining in southeastern Missouri and describes the potential mineral activities which could occur in the event mineral leases are issued.

BACKGROUND

In November of 1983, USX (formerly U.S. Steel Corporation) and AMAX Exploration, Inc. filed two lease applications to develop and produce lead, zinc, copper and associated Federal minerals on 3743 acres within the Mark Twain National Forest. The Forest is located in southcentral Missouri about 120 miles southwest of St. Louis and 100 miles east of Springfield (Figure 1). After filing the applications, USX and AMAX assigned all interests to St. Joe Minerals Corporation. St. Joe has since combined its interests with Homestake Minerals to form Doe Run Corporation. Doe Run currently holds the interests in the two applications.

After receiving the applications, the Forest Service initiated the preparation of a preliminary environmental assessment (EA). However, in October of 1986, prior to completing the EA, the Forest Service and Bureau of Land Management (Bureau) determined that the analysis area should be enlarged to include those areas available for future lease applications and that an environmental impact statement (EIS) should be prepared to assess the potential impacts of mineral development. Further, it was decided that the analysis be conducted jointly by the two agencies. This determination was based on public concerns about potential adverse environmental effects and the need to consider potential future mineral applications.

Because a lease conveys the right to develop and produce Federal minerals, this analysis considers all possible environmental effects which could result from a full range of mineral activities. The EIS considers the potential effects of mineral activities over the entire study area, not just within the lease application areas. Further, because this analysis is in response to a lease application rather than a specific mining proposal, it considers various mining techniques, including alternative waste disposal methods.

Study Area

The study area is located in Shannon, Oregon and Carter Counties. The area includes approximately 119,000 acres of National Forest System Lands and federally-owned minerals administered by the Mark Twain National Forest and Bureau, respectively. Local communities adjacent to the area include Winona, Alton, Birch Tree, Green, Fremont, Van Buren, Wilderness, Thomasville and Doniphan (Figure 2).

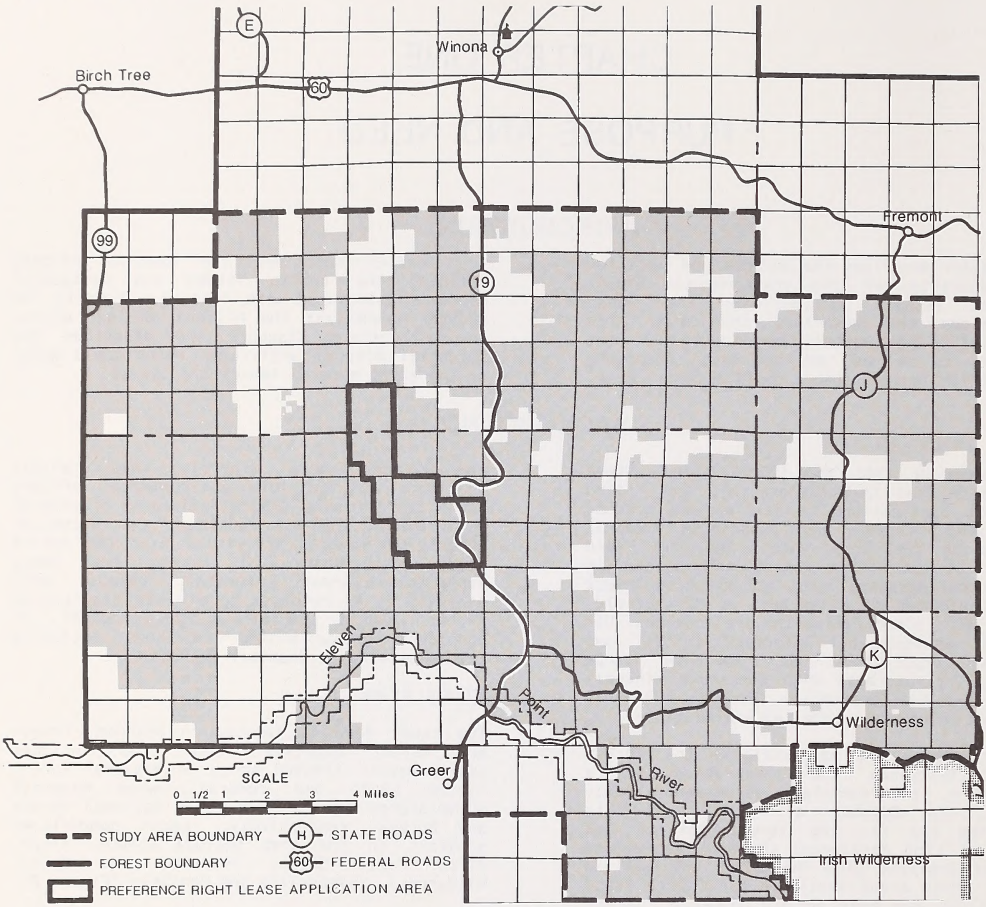
Although there are two lease applications encompassing 3743 acres currently pending, a substantially larger area was delineated for analysis. This larger area is based on geologic land use and geographic conditions, because additional lease applications are anticipated in the future. Currently there are 10 prospecting permits and one pending permit application.

DECISIONS TO BE MADE

There are two decisions to be made regarding hardrock mineral leasing within the study area. These decisions are whether or not to consent to and issue competitive and non-competitive mineral leases for all federally-owned minerals within the study area and, if so, under what terms and conditions.

It is important to note that mineral exploration under Bureau issued prospecting permits has been conducted within the study area and that such activities will be permitted in the future. Use of the term "exploration" within this document refers to core drilling activities which occur under authority granted through a mineral lease, not that conducted under a prospecting permit. Decisions regarding lease issuance do no affect the right to explore for minerals under authority of a prospecting permit.

Figure 2: EIS STUDY AREA AND SURROUNDING COMMUNITIES



Forest Service Decision

The Forest Service must determine whether or not mineral leasing is consistent with the purposes for which the lands were acquired and are being administered. If such activities are consistent, the Forest Service consents to lease issuance and provides the Bureau with any conditions necessary to protect resource values and uses. All conditions provided by the Forest Service must be included in any lease issued.

Bureau Decision

Under the provisions of Section 402, Reorganization Plan No. 3 of 1946 and guided by regulations at 43 CFR 3560, the Bureau is responsible for leasing all Federal minerals beneath the Mark Twain National Forest. If the Forest Service provides consent, the Bureau must decide whether or not to issue a lease(s) and if so, the terms and conditions to be applied to the lease.

LEGAL AUTHORITY

All Federal lands acquired under the Weeks Law are open to mineral exploration, development and production unless excluded by either public law or administrative withdrawn. This disposal authority comes from the Act of March 4, 1917, (39 Stat. 1134, 1150; 16 U.S.C. 520) which states:

> "The Secretary of the Interior is authorized, under general regulations to be prescribed by him, to permit the prospecting, development, and utilization of the mineral resources of the lands acquired under the Act of March first, nineteen hundred and eleven (Thirty-sixth Statute, page nine hundred and sixty-one), known as the Weeks Law, upon such terms and for specified periods or otherwise, as he may deem to be for the best interests of the United States; and all moneys received on account of charges, if any made under this Act shall be disposed of as is provided by existing law for the disposition of receipts from national forests."

Furthermore, mineral development is authorized by Section 402 of Reorganization Plan No. 3 of July 16, 1946 (60 STAT. 1097, 1099; 5 U.S.C: Appendix 2), which transferred the functions of the Secretary of Agriculture in that regard to the Secretary of the Interior. Certain constraints were placed upon such development:

> "Mineral development on such lands shall be authorized by the Secretary of the Interior only when he is advised by the Secretary of Agriculture that such development will not interfere with the primary purposes for which the land was acquired and only in accordance with such conditions as may protect such purposes. The provisions of law governing the crediting and distribution of revenues derived from the said lands shall be applicable to revenues derived in connection with the functions transferred by this section. To the extent necessary in connection with the performance of the functions transferred by this section, the Secretary of the Interior and his representatives shall have access to the title records of the Department of Agriculture relating to the lands affected by this sections."

Thus, the Secretary of Agriculture has either power to veto mineral development in order to protect National Forest System lands, or to consent to mineral activity, adding stipulations to protect the lands.

More recently, Congress reiterated its intent to allow mineral development under appropriate circumstances when it enacted the Mining and Minerals Policy Act of 1970, 84 STAT. 1876; 30 U.S.C. 21, a. The act states:

> "The Congress declares that it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in (1) the development of economically sound and stable domestic mining, mineral, metal and mineral reclamation industries, (2) the orderly and economic development of domestic mineral resources, reserves, and reclamation of metals and minerals to help assure satisfaction of industrial, security and environmental needs...."

Leasing on Acquired Lands

Gaining the right to develop and produce Federal hardrock minerals (such as lead) beneath acquired Forest Service lands, is generally a two stage process involving the issuance of prospecting permits and preference right leases. If and when mineable deposits are established, leasing would occur competitively (Appendix 2).

There are two applications for lease in the study area. Other applications may be submitted in the future. If and when a lease is issued, the lessee must submit a plan of

operations for approval before developmental drilling or production can occur.

A separate environmental analysis, which may include public involvement, is prepared prior to prospecting permit issuance, exploration plan approval, lease issuance and mine plan approval.

A lease grants the right to develop and produce a specific mineral within the lease area subject to lease terms and conditions. The primary lease term is for 20 years with successive 10 year renewals granted consistent with Bureau criteria including diligency requirements. Rental rates are $1 per acre per year If and when production commences, payments are made monthly to the Minerals Management Service for deposit to the U.S. Treasury based on a pre-established royalty rate. Twenty-five percent of all Federal rental and royalty receipts are returned to the State of Missouri for disbursement to county governments.

Mitigation Measures

Although standard lease terms and conditions (Appendix 2) frequently provide sufficient protection for surface resource values and uses, the inclusion of specific stipulations may be necessary. Typically, stipulations consist of either seasonal restrictions or no surface occupancy. The seasonal restriction limits or precludes lease operations during a specific time period. The no surface occupancy stipulation precludes all surface-disturbing operations on a specified portion (or total) of the lease area during the lease term. Further, stipulations may reduce or eliminate surface use conflicts. If surface-disturbing activities cannot be permitted at any time, the Bureau prefers to lease the area with no surface occupancy rather than denying lease issuance. The applicant then decides whether or not to accept the lease. A lease with a no surface occupancy stipulation may be accepted if the applicant believes reasonable off-lease access exists.

Conditions of approval for plans of operation are established after lease issuance but prior to approving the plan. Many of these conditions are agreed to at an on-site meeting between the lessee, the Forest Service and the Bureau. The conditions are identified during an analysis of the plans of operation. Due to provisions contained within existing Bureau regulations or the lease instrument, conditions of approval need not be attached to the lease but, rather, are included as site-specific requirements in plans of operation.

Forest Plan

The Forest is currently managed under the Mark Twain National Forest Land and Resource Management Plan (Plan). This Plan outlines a 10 to 15 year strategy to realize a "desired future forest condition." The Plan specifies management prescriptions and standards to achieve this future condition. The standards define specific practices, activities or mitigation measures to ensure attainment of the management prescription objectives. These are discussed in detail in Chapter IV of the Plan.

The Plan does not identify site-specific proposals but rather sets the standards for reviewing projects. Proposals to use National Forest System lands are reviewed for consistency with the Plan. The Forest Plan identifies twelve different management prescriptions ranging from maximum commodity production to maximum resource protection. Each has specific standards to ensure resource protection. Various portions of the EIS study area contain different management prescriptions. These prescriptions and their accompanying standards provide the framework under which mineral leasing may occur. Further, the standards are the basis for lease stipulations and conditions of approval for operations.

Regulatory Authority

The requirements of numerous Federal and State of Missouri regulations must be satisfied before surface disturbing activities including exploratory drilling and the construction and operation of one or more mines will be permitted. The principle laws governing the process are outlined in Tables 2 and 3.

SUMMARY OF SCOPING

The Council on Environmental Quality Regulations require that at the initial preparation stages of an environmental impact statement there be an ". . . early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. This process shall be termed scoping (40 CFR 1501.7) ."

The objectives of scoping are: (a) to identify the affected public and agency concerns; (b) to facilitate an efficient EIS preparation process; (c) to identify and define the issues and alternatives to be examined in detail; and (d) to save time in the overall process by ensuring that the EIS adequately addresses the relevant issues.

The original analysis focused on the two lease applications encompassing 3743 acres. The Forest analyzed the proposal and initiated the preparation of an environmental assessment. This was mailed to numerous concerned individuals, organizations and agencies. There were numerous comments and concerns that the assessment failed to consider future leasing and did not adequately address specific resource issues.

As a result of public comments, in October of 1986, prior to completion of the assessment, the Forest Service and Bureau decided that an

TABLE 2
MAJOR FEDERAL REGULATIONS GOVERNING HARDROCK EXPLORATION AND PRODUCTION

MANDATE	ADMINISTERING AGENCY	ACTIVITY
Clean Water Act, as amended	U.S. Army Corps of Engineers Environmental Protection Agency	Regulation of activities in or affecting waters of the United States; control and abatement of water pollution
Federal Water Pollution Control Act	Environmental Protection Agency	Spill prevention, control and counter-measure plan
National Historic Preservation Act	USDA-Forest Service	Protection of historic and archeological resources
Endangered Species Act of 1973, as amended	U.S. Fish and Wildlife Service	Protection for threatened or endangered plant and animal species
Section 402, Reorganization Plan No. 3	Bureau of Land Management	Mineral exploration and production on acquired Federal lands
Federal Mine Safety and Health Amendments Act of 1977	Mine Safety and Health Administration (MSHA)	Inspection of mine operations
Resource Conservation and Recovery Act of 1976	Environmental Protection Agency	Disposal of mine wastes
Flood Plain Management Executive Order 11988	USDA-Forest Service	Activities in or affecting floodplains
Protection of Wetlands Executive Order 11990	USDA-Forest Service	Activities in or affecting wetlands
Farmland Protection Policy Act	USDA-Soil Conservation Service	Activities within or affecting prime or unique farm lands
Safe Drinking Water Act, as amended	Environmental Protection Agency	Activities which release effluent to area waters
Surface Mining Control and Reclamation Act of 1977, as amended	Office of Surface Mining	Designation of lands unsuitable for surface non-coal mining
Archeological Resource Protection Act of 1979	USDA-Forest Service	Protection of archeological and cultural resources
National Environmental Policy Act, as amended	USDA-Forest Service and Bureau of Land Management	Protection of the environment

Source: USDA-Forest Service and Bureau of Land Management, 1987.

environmental impact statement should be prepared. A Notice of Intent to prepare an EIS was published in the Federal Register on November 7, 1986 (51 FR 40473-74). Two public meetings were held, one in Jefferson City, on December 10, 1986, and the other in Winona, on December 11, 1986. In addition, Federal, State, and local agency meetings were held in the same cities, prior to the public meetings. Attendees were encouraged to send written comments to the Forest Supervisor, Mark Twain National Forest.

As required by the Council on Environmental Quality Regulations, the information obtained during the scoping process was used to guide the preparation of this EIS and will be considered fully in the decision processes of the Forest Service and Bureau.

ANALYSIS OF COMMENTS

The following is a summary of the comments received during both the Environmental Assessment (EA) public review period and the EIS scoping process. The detailed analysis of all comments received during the public review process is contained in Appendix 3.

During the EA review period, a total of 78 responses were received from the public. The responses consisted of 75 letters or mailbacks and three petitions containing a total of 35 signatures.

Thus, a total of 110 persons expressed their thoughts on the EA. Of these, 28 lived within the six-county area, or within or adjacent to the study area (Shannon, Howell, Oregon, Ripely, Butler and Carter). The remaining

TABLE 3
MAJOR STATE OF MISSOURI REGULATIONS GOVERNING HARDROCK EXPLORATION AND PRODUCTION

MANDATE	ADMINISTERING AGENCY	ACTIVITY
Missouri Air Conservation Law (Chp. 643; 10 CSR 10-6.060)	Missouri Department of Natural Resources	Construction of new facilities which may emit contaminants
Missouri Clean Water Law (Chp. 644; 10 CSR 20-6.010 & 6.020)	Missouri Department of Natural Resources	Construction and operation of wastewater treatment facility which will discharge effluent into State waters
Missouri Hazardous Waste Management Law (Chp. 260)	Missouri Department of Natural Resources	Disposal of mine waste
Missouri Dam and Reservoir Act (Chp. 10 CSR 22-3.040 22-3.050)	Missouri Dam and Reservoir Safety Council	Construction and operation of industrial water retention dams over 35 feet high
Missouri Safe Drinking Water Act (Chp. 640p; 10 CSR 60)	Missouri Department of Natural Resources	Development of potable water supplies
Mining Regulation (Chp. 293; 293.010-.690 RSMO)	Missouri Department of Labor and Industrial Relations	Inspection of mine operations
Mining Regulation (Chp. 444; 444.010-.330 RSMO)	Missouri Department of Labor and Industrial Relations	Mining activities
Missouri Clean Water Act (Chp. 644)	Missouri Department of Natural Resources	Plugging abandoned well and test holes
Construction of Water Supply Wells [Chp. 77; 13 CSR 20.7015(c)]	Missouri Department of Social Services	Construction of water wells
Water Well Drillers [Chp. 256; 10 CSR 20.7015(7)(c)]	Missouri Department of Natural Resources	Construction of water wells
Major Water Users Law (Chp. 256; 256.410 RSMO)	Missouri Department of Natural Resources	Use of water wells
Missouri Clean Water Regulations (10 CSR 20-7.031 and 7.015)	Missouri Department of Natural Resources	Wastewater Treatment facilities effluent regulations and water quality standards

Source: Missouri Department of Natural Resources, 1987.

commentors lived in other locations within the State of Missouri (69) or outside the State (13).

A total of 241 comments was summarized from the 75 letters and petitions. The comments formed the basis for the decision to prepare an EIS for hardrock mineral leasing.

During the EIS scoping process, a total of 117 responses was received, representing 583 persons. There were 43 oral statements made at the public meetings. Written responses included 68 letters, four petitions, one resolution and one report.

The six-county area was well represented with 48 responses, representing 513 persons, many of whom signed one of several petitions. An additional 63 responses were received from residents of other Missouri locations and six persons outside the State. Most responses were submitted by individuals. However, the mining industry and various organizations, professional societies, elected officials and public agency individuals expressed their concerns.

A content analysis of the 117 responses was used to summarize the major points of concern. Since most responses contained several comments, a total of 633 comments were identified from the EIS scoping responses. Comments were categorized and displayed by affected environment and provided to the EIS Team for analysis and identification of issues.

Using the scoping information, the EIS Team identified eight major issues and two management concerns. The term "issue" refers to a topic raised by public and the terms "concern" to a topic raised by Federal land

managers.

ISSUES

Water

The public expressed concerns that mining would degrade water resources creating hazards which would affect public health, safety, wildlife, tourism and the quality of Ozark life.

Land Character

The public expressed the concern that mineral activities would unaccept- ably change the lifestyle and experiences of the residents and visitors to the study area. The land provides an abundance of natural resources in a rugged, remote and scenic setting. The quality of life is often measured by the presence of these natural resources.

Jobs, Economy and Lifestyle

Many individuals expressed considerable interest for additional jobs and income that mining-related activity could bring to the area. They also expressed concerns that jobs and income related to mining would be of temporary duration and would affect local lifestyles and other industries, including recreation and tourism.

Threatened and Endangered Species

The public voiced concerns that mineral activities would adversely impact habitats and populations of wildlife and plant species. Many of these species are Federally or State listed threat- ened or endangered species.

Lead Market

The public commented on current and anticipated future lead market conditions. They questioned the need for additional lead sources and whether it was economically mineable. Conversely, some comments defined the need for additional lead sources to assure a stable long-term supply for the nation.

Land Use Purpose

The public expressed concerns that mineral production and development is not consistent with the purposes for which National Forest lands were acquired; that mineral activities would either preclude the use and enjoyment of other National Forest resources, or that the Forest Service and the Bureau would not exercise their authority to adequately protect such resources.

Areas of National Significance

Individuals are concerned that mining activities could adversely affect the congressionally designated areas comprised of the Eleven Point National Scenic River, Ozark National Scenic Riverways, the Irish Wilderness and Excluded Lands; the administratively designated Cupola Pond and other designated natural, scenic or geologic areas including Greer Springs.

EIS Schedule

The public was concerned that the schedule did not provide sufficient time to adequately analyze the possible effects of mining in the study area. This issue is not carried forward in the analysis because it is nonsubstantive. That is, it is not an issue around which alternatives are developed or evaluated. It is, however, a criterion by which the public can evaluate the entire analysis.

CONCERNS

The following management concerns were identified by the EIS Team.

Compatibility With Forest Plan

Whether possible mining activities in this area would be compatible with the Forest Plan.

Land Available for Development

Whether there are sufficient Federal lands available for lease and development to ensure a continued flow of mineral commodities.

HISTORY OF LEAD MINING IN MISSOURI

Lead was first discovered in southeastern Missouri by French explorers in 1700. Mining began in 1720 at Mine LaMotte. With the discovery of subsequent deposits, lead mining has been pursued in the area almost continuously ever since. Nearly all the lead ore mined in the area prior to 1869 was from scattered, shallow workings. In 1864, the St. Joseph Lead Company (St. Joe) was organized and began operations at Bonne Terre, Missouri, where ore was mined from a shallow trench. Subsequent exploration, by drilling, resulted in the discovery of disseminated lead ore in the underlying Bonneterre Formation and lead to a rapid increase in underground mining. This marked the beginning of major lead production in Missouri.

The area near Bonne Terre, Leadwood, Desloge and Flat River, is referred to as the "Old Lead Belt." As many as 15 companies were operating in the Old Lead Belt in the late 1800's and early 1900's. However, by 1933, St. Joe had acquired the holdings of all other companies, except for mines held by the National Lead Company. Uninterrupted mining continued in the Old Lead Belt until depletion of the ore body forced the gradual shutdown of operations. The last mine ceased operations in 1972. The Old Lead Belt produced over 8 million tons of lead during 108 years of operation. It was the nation's largest lead producing area.

Initially the ore was treated by crude methods and waste was disposed of in tailings piles.

Tailings are the residue remaining after the lead ore is crushed, and the lead sulfide (galena) is separated and removed from the dolomite. Five remaining tailing piles are located in the Old Lead Belt consisting of finely ground dolomitic residue. Heavy metals remain in significant quantities in the tailings because of the technology used to process the ore at the time. The location of the tailings piles has resulted in leachate and sediment entering streams in the area. Efforts are presently underway to stabilize these piles and eliminate sedimentation and leaching into local streams.

Under existing law, State and Federal Governments require the approval of plans covering the design, construction, site location, abandonment and maintenance of tailings disposal facilities. Current technology for handling mill tailings involves the use of tailings impoundments, not piles, which allow for better control of leachate and erosion. Further, because of more efficient milling processes used today, tailings contain much lower concentrations of heavy metals than those of the Old Lead Belt.

Around 1943, when it was apparent that the ore reserves in the Old Lead Belt were approaching depletion, St. Joe started an extensive exploration program. Starting west of the Old Lead Belt, the company began core drilling and discovered the Indian Creek deposit in 1948. This deposit proved to be an isolated occurrence, so drilling continued elsewhere. In 1955, St. Joe discovered a mineable deposit within the boundaries of the Mark Twain National Forest 30 miles west of the Old Lead Belt. More than 20 companies entered the areaand an extensive drilling program began, resulting in the delineation of the New Lead Belt.

The New Lead Belt, or Viburnum Trend (Trend), extends south from the Town of Viburnum for 35 miles. St. Joe developed the first mine, which went into production in 1960. The Cominco-Dresser, Amax-Homestake and Ozark Lead Company opened mines in the late 1960's. St. Joe also developed two additional mines south in the Trend. Asarco has recently developed the newest mine. This will reach full production in 1987.

The Trend contains the largest domestic lead reserves currently known, producing 90 percent of the U.S. supply, and is the largest lead mining area in the world. Today, seven mines are producing in the Trend with two mines temporarily shut down. The Viburnum Trend is expected to produce at present levels to the year 2000, with production declining rapidly thereafter. Because of the relatively short remaining field life, lead mining companies have begun extensive lead exploration programs in Missouri. The most promising area identified so far in the United States is directly south of the Viburnum Trend in the Winona-Doniphan-Van Buren Ranger Districts of the Mark Twain National Forest. This area has been the focus of all recent exploration conducted by the lead mining industry. Currently there are ten prospecting permits and one permit application pending. Figure 3 illustrates the locations of lead mining activities in southeastern Missouri.

POTENTIAL MINERAL ACTIVITIES

Though permission to lease is being sought, there are no actual mining proposals at this time. In order to assess the potential impacts of mining activities, it is necessary to establish hypothetical "scenarios" to approximate the levels and types of activities which may occur in the event one or more leases are issued. The following is a description of potential activities which will be used to assess the type and magnitude of potential impacts.

The EIS study area as shown on Figure 2 is a region of great interest to lead-zinc mining companies because of its favorable geologic conditions for containing lead and other associated metals. The mineralization of the area is similar to, but on a much lower level than that presently being mined in the Viburnum Trend. Extensive exploration drilling under prospecting permits has been ongoing for the past 8 years with approximately 250 holes drilled to date. Most of the holes have not revealed favorable mineralization; however, a few "pay holes" have been drilled. A "pay hole" is a drill hole which encounters mineralization in sufficient thickness and grade to indicate the presence of an orebody. An ore body is a mineral deposit that can be profitably developed to yield metals, in this case lead and associated metals. The Preference Right Lease Applications submitted by U.S. Steel Corporation (USX) for Prospecting Permits ES-19219 and ES-19220 were initiated because of the presence of pay holes.

The following narrative describes three possible levels of mineral development which may occur in the study area. The lowest level of development would entail exploration drilling only which would not result in the discovery of sufficient reserves to constitute a mineable orebody. This is referred to as the "Exploration Scenario." The second level of development would entail exploration drilling and the construction of one mine. This is referred to as the "Low Development Scenario." The third, or highest level of mineral development, would entail a Viburnum Trend-scale mining district consisting of 8 mines, and is referred to as the "High Development Scenario," with each mine identical to the hypothetical mine described in the "Low Development Scenario." Table 4 summarizes projected primary employment and Table 5 summarizes surface acres disturbed for each development scenario. A hypothetical timeframe for each scenario is shown on Figure 4.

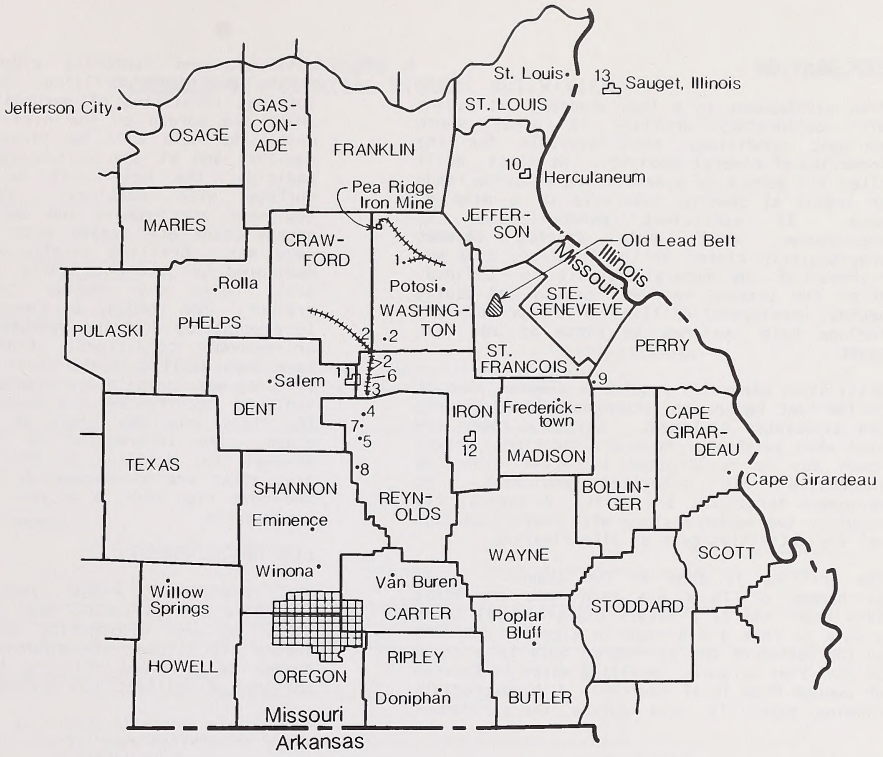


Figure 3: LEAD AND ZINC MINING IN SOUTHEAST MISSOURI

Old Lead Belt

Viburnam Trend Mines

1 Indian Creek Division Mines & Mill (abandoned)
2 Viburnam Division Mines & Mill (producing)
3 Buick Division Mine & Mill (producing)
4 Brushy Creek Division Mine & Mill (production suspended)
5 Fletcher Division Mine & Mill (production suspended)
6 Magmont Mine & Mill (producing)
7 West Fork Mine & Mill (producing)
8 Sweetwater Mine & Mill (production suspended)
9 Higdon Mine (partially developed)

Lead Smelters

10 Herculaneum Division Plant
11 Buick Division Plant
12 Glover Plant
13 Electrolytic Zinc Plant

Railroad Spur

Study Area

EXPLORATION

Mine development is a long process. It begins with exploratory drilling in areas where geologic conditions are favorable for the formation of mineral deposits. At first, drill sites are generally placed along existing roads or trails at spacing intervals of a mile or more. If sufficient mineralization is encountered, drill hole spacing becomes progressively closer as the location, size and richness of the mineral deposit is defined. After the orebody has been proven and mining begins, development drilling of the orebody may include hole spacings as close as 300 feet apart.

Drill sites generally require a cleared area of 50-100 feet square to accommodate the drill rig and associated equipment. Existing roads are used when available; however, additional access roads may be constructed in areas otherwise inaccessible to motorized equipment. No permanent structures are built. A typical rig requires two workers along with support personnel for activities such as site clearing.

The drilling is done in two stages: 1) an air-hammer drills a 4-8 inch hole the first 1200 feet; and 2) a rotary diamond drill takes a core of rock 1 1/8 inch in diameter starting at the bottom of the air-hammer hole to a depth of 2000 feet or more. Drilling water is trucked or pumped from local sources. A biodegradable foaming agent is used during the air-hammer drilling, and bentonite clay will be used during the core drilling operation. Drill cuttings consisting of natural rock flour and chips are spread on the site. Upon abandonment, the hole will be plugged to seal off aquifers and at the soil-bedrock contact. In addition, the hole will be filled to the surface with cuttings. All refuse and equipment are removed and the drill site and access roads are seeded with a predetermined seed mix. Drilling results are continuously monitored to determine where to place future drill holes and whether to continue the project. The company or companies may decide to discontinue drilling because of poor results or economic conditions. Although pay holes have been drilled in the study area, additional drilling may indicate any promising holes to be isolated occurrences and mineral activity in the study area may cease at the exploration stage. The information in Tables 4 and 5 assumes that drilling is discontinued in the area after one air-hammer drill operates with two core rigs over a 6 year period with no discoveries.

TABLE 4
PRIMARY EMPLOYMENT LEVELS
(Number of Workers)

SCENARIO	CONSTRUCTION	MINE WORKERS
EXPLORATION	-	7
LOW DEVELOPMENT	70	100
HIGH DEVELOPMENT	560	800

Source: Bureau of Land Management, 1987.

LOW DEVELOPMENT

The preference right lease applications (ES-19219 and ES-19220) are a result of pay holes on the prospecting permits. If the leases are issued, the company would probably decide to continue drilling these areas with the hope of delineating a mineable orebody.

A mineable deposit generally consists of at least 15 million tons of ore averaging 5% lead in a reasonably compact unit. Delineating such a deposit generally entails intersecting an ore zone with 25 drill holes within a 200 to 300 acre area. Since the historic pay hole/blank hole ratio is 1:4, approximately 100 holes would be required to delineate a deposit. That would take approximately 3 years. Finding a mineable deposit could accelerate exploration activity on adjacent areas. This scenario, however, assumes that exploration in the rest of the study area results in no additional discoveries and that only one mine is developed.

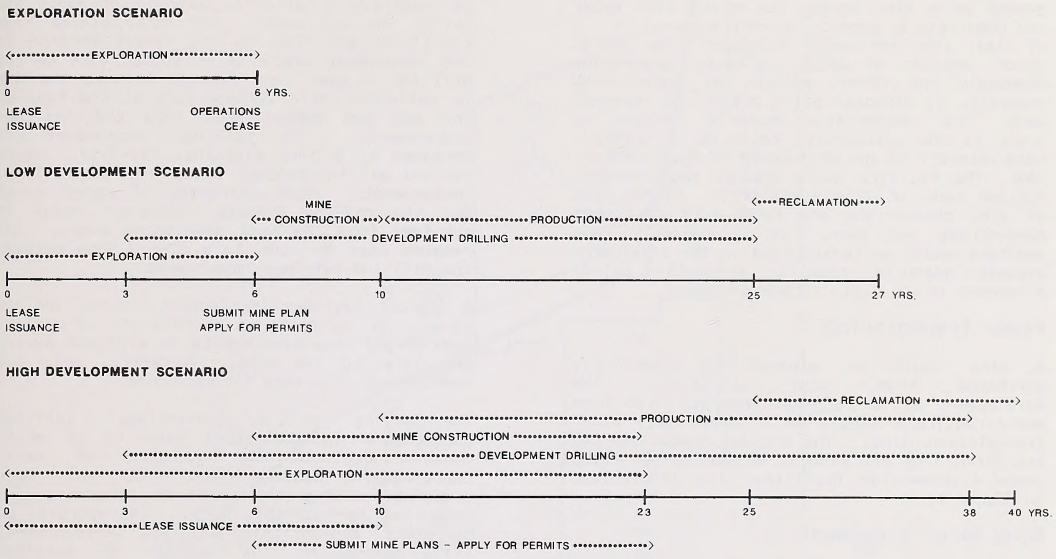
If a mineable deposit is delineated, the company would then determine the timing and method of development. Plans would be developed for the construction of surface

TABLE 5
SUMMARY OF SURFACE ACRES DISTURBED BY POTENTIAL MINERAL ACTIVITIES

SCENARIO	DRILLING ACCESS ROADS	DRILL PADS	ACCESS ROADS	POWER LINES	MINE FACIL.	TAILINGS IMPDS.	MINE WATER CLARIF. IMPDS.	TOTAL
EXPLORATION	4	26	-	-	-	-	-	30
LOW DEVELOPMENT	15	80	12	44	30	250	20	451
HIGH DEVELOPMENT	120	640	96	79	240	2000	160	3335

Source: Bureau of Land Management, 1987.

FIGURE 4
SCHEDULE OF POTENTIAL MINERAL ACTIVITIES



NOTE: THE HIGH DEVELOPMENT SCENARIO ASSUMES ESTABLISHMENT OF 8 MINES LEASED OVER A 10 YEAR PERIOD (YEARS 0 THROUGH 10) WITH PRODUCTION INITIATED OVER A 14 YEAR PERIOD (YEARS 10 THROUGH 23).

Source: Bureau of Land Management, 1987

facilities and underground mine workings. Forest Service and Bureau approval are required before operations could occur. Numerous permits and authorizations are required from other Federal and State agencies (Tables 2 and 3). Approximately 3 years would be required to develop plans and receive all necessary authorizations.

Mining Method

The mining method(s) used would reflect the site-specific character of the orebody and host rock. It is likely that a variation of the room and pillar mining presently used on the Viburnum Trend would be appropriate. In the event room and pillar methods are used, twenty-eight foot diameter pillars would be left for roof support with rooms averaging 32 feet in width. Usually 80% or more of the ore is extracted. Mining heights would vary from a minimum of 10 feet up to 100 feet depending on the thickness of the mineralization. Approximately 8-10 working faces would be blasted daily between shifts to maintain a proper mill feed tonnage of 4000 tons per day (TPD). Three or four jumbo drills, with two person crews working two shifts daily, would be needed to drill and blast the faces. In the initial development of the mine, front-end loaders could be used for the entire mucking cycle. As the mine develops out from the shaft, the front-end loader would be used in conjunction with one or two 40-ton haul trucks. Usually, two mucking crews would be used per shift, loading rock from a blasted face in two to three hours. Numerous support personnel and equipment consisting of scalers, road graders and service trucks would be used to supplement the basic production crews.

As the mine progresses, vent shafts would be erected to supply air for the workers and to remove the exhaust gases from the equipment and blasting. Holes would be established approximately every 1000 feet along the orebody by drilling an 8-12 inch pilot hole from the surface and upreaming this hole into a 44 to 60 inch vent shaft. The fans may be located on the surface or underground and would be supple- mented by booster fans and tubing to deliver the air where it is needed underground. Approximately five vent shafts would be needed. An estimated 500 development drill holes would be drilled over the 15 year mine life.

Milling

Ore would be processed on the surface in a mill which crushes, grinds and floats it to separate the ore minerals from the waste. The ore is ground to a fine powder and mixed with water and chemicals to produce concentrates of lead, zinc and copper minerals. The waste, which consists of water, dolomite, processing chemicals and minor amounts of unrecovered minerals, is disposed of in a tailings impoundment. Ore concentrates would be shipped by truck to the appropriate railhead or smelter. Lead recovery in the mill would be approximately 98%. The facility would produce approximately 100,000 tons of lead concentrate, 10,000 tons of zinc concentrate and 5,000 tons of copper concentrate per year. It is unlikely that smelters would be constructed in the study area because adequate capacity presently exists elsewhere in this country and overseas.

Power Transmission

A mine would be powered by electricity purchased from local utilities. The development of a small to moderate size mine would require a single 69 kilovolt (KV) power transmission line. The closest power sources are Birch Tree and Winona, Missouri. Existing power transmission facilities are illustrated on Figure 5.

Mine Water Treatment

Water seeping into the mine would be pumped to a small man-made impoundment. Similar impoundments in the Viburnum Trend are typically 20 acres in size. This would be build utilizing a small earth dam. Mine water would be retained in the impoundment a sufficient length of time for all solid material to settle out before discharge into natural waterways.

The volume of water to be pumped from a mine is unknown, as site-specific factors can cause great variances. The volumes encountered on the Viburnum Trend range from 300-5000 gallons per minute (gpm). A portion of the water pumped from the mine would be used in the milling of ore.

Tailings Disposal

Mine tailings are typically disposed of in an impoundment area formed by the construction of a dam. After all permits and authorizations are obtained, the company would begin construction of the earthen dam. The location of the impoundment would be selected and dam sites would be tested to assure structural competence of underlying rock. The dam would begin as an impermeable starter dam constructed of natural clay soil with a coarse rock filter blanket placed on the downstream side. Tailings from the milling process would be transported by slurry pipeline to a cyclone which separates the coarse particles, or "fractions", from the fines. The coarse fraction would be placed on the downstream side and the fines on the impoundment side to seal the dam. This process would continue until the final height of the dam is reached. At that time a permanent spillway would be installed to handle the overflow anticipated from storms.

Tailings slurry typically consists of about 35% solids and 65% water. The water drains from the slurry and flows to the lowest section in the impoundment where it is pumped back to the mill for re-use. Any seepage through the dam is collected in a seepage pond at the base of the dam and pumped back into the tailings impoundments. The tailings impoundment is designed as a zero discharge facility. Water for the milling process comes from the tailings impoundments. When shortages of water exist for the milling process, "make-up" water is obtained from the mine dewatering pumps. All reagent used is kept in a closed loop between the mill and tailings impoundment.

A typical tailings impoundment covers 200-300 acres. It is designed to hold the 15 million tons of tailings expected to be produced during the life of the mine. Therefore, only one impoundment is needed for each mine.

The siting of a conventional tailings impoundment in the study area is of major concern due to the presence of karst topography. Studies have not yet been conducted within the area to determine the potential for suitable sites. The approval to construct conventional tailings impoundments will depend on the results of detailed studies. Such studies will assess the structural integrity of underlying rock, the character of the alluvium/colluvium, the hydrogeology and existing stream quality. In the event such studies concluded that suitable sites did not exist, other methods of tailings disposal would be evaluated.

Reclamation

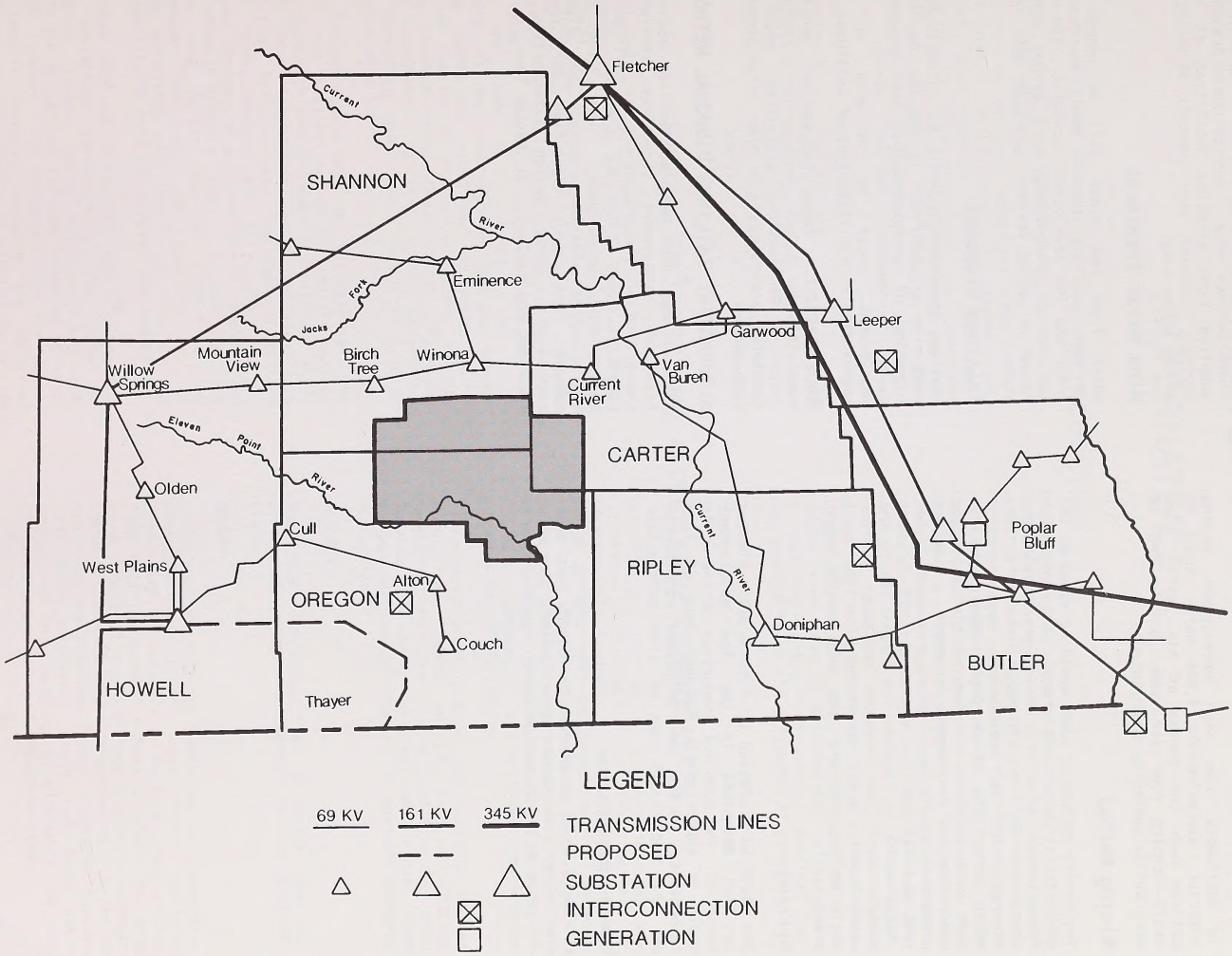
Mine reclamation will be completed after production ceases. Reclamation would include the removal of surface structures, the permanent plugging of mine and vent shafts and the revegetation of disturbed areas including tailings impoundments. Specific reclamation activities will be conducted according to a plan developed in conjunction with the mine plan. Approval of the plan will be subject to additional analysis including public involvement.

HIGH DEVELOPMENT

Exploration drilling may result in the delineation of several mineable ore deposits in the study area. Although based on preliminary geologic investigations the probability for the occurrence of multiple ore deposits is very unlikely, a high development scenario has been established to fully address a wide range of possible environmental effects. The high development scenario is designed to approximates the size of the Viburnum Trend mining district. For analytical purposes, it is assumed that there will be sufficient deposits found to establish eight mines of the type

Figure 5

INTERCONNECTED MISSOURI COOPERATIVE TRANSMISSION FACILITIES



described in the low development scenario.

To delineate the high development mining district, approximately 4,000 holes would be drilled over the course of six years. This would require four air-hammer drills and 10 core drills operating continuously.

Mining Method

The mining method(s) used would be based on the characteristics of the orebody and host rock formations, as in the low development scenario. It is assumed that sufficient mineralization is present to develop eight mines within the study area. Operations in each mine would be the same as that described under the low development scenario. Combined production levels would be an estimated 32,000 tons per day. It is estimated that 40 vent shafts would be required to supply air to the mines and to remove exhaust gases. Approximately 4,000 development drill holes would be required over the life of the eight mines.

Milling

Ore would be processed by 4 to 8 mills similar to that described in the low development scenario. The combined production of the mills would be approximately 800,000 tons of lead concentrate, 40,000 tons of copper concentrate per year and 80,000 tons of zinc concentrate per year.

Power Transmission

All mines would be powered by locally purchased electricity. To power several mines the size of those in the Viburnum Trend would require one 161 KV power transmission line with feeder lines to each mine. Service would probably be supplied from existing facilities at Willow Springs, Missouri, approximately 35 miles west of the study area.

Mine Water Treatment

Water from the mines will be pumped into man-made settling impound- ments as described under the low development scenario. The number and size of impoundments will depend upon the volume of water encount- ered in each of the mines.

Tailings Disposal

Tailings impoundments would be established for each mine as described in the low development scenario. It is assumed that each impoundment would encompass 200-300 acres. Each impoundment would be designed to hold approximately 15 million tons of tailings.

Reclamation: Mine reclamation would be completed for each mine after production ceases. Reclamation activities would be completed according to a plan established for each mine.

ALTERNATIVE TAILINGS DISPOSAL METHODS

The tailings impoundments described above are based on impoundment structures similar to those used in the Viburnum Trend. Due to the potential risks posed by the use of such conventional impoundments within the study area, various facility designs and disposal options have been identified for further evaluation. These design alternatives are described and evaluated in Chapter Four.

CHAPTER TWO

ALTERNATIVES

INTRODUCTION

The principle purpose of this Chapter is to identify and describe the five alternatives established to evaluate potential effects of mineral-related activities. A summary of potential environmental effects of each alternative is also presented. A detailed analysis of potential effects discussed by issue is presented in Chapter Four, Environmental Consequences. The alternatives are:

Alternative A:	No Leasing
Alternative B:	Full Leasing
Alternative C:	Forest Plan
Alternative D:	Modified Forest Plan (Visual Quality)
Alternative E:	Modified Forest Plan (Visual Quality and 6.2 Management Area)

The alternatives represent a full range of possible actions that can be taken by the decision maker. Each of the alternatives is technically and economically feasible. Each is distinctly different from the other and lends itself to independent analysis. The alternatives were developed in response to issues expressed by public agencies and members of the public and to concerns identified by the Bureau and the Forest Service. The process used to formulate alternatives is described below and illustrated in Figure 6. This Chapter summarizes the possible effects of mineral activities by alternative. Alternative D: Modified Forest Plan (visual quality) has been identified as the Preferred Alternative.

ANALYSIS PROCESS AND ALTERNATIVE FORMULATION

This analysis was triggered by two lease applications for the development and production of Federal minerals. While no actual plan of operations have been submitted, it is necessary to analyze the effects of potential mineral activities, to ensure that the rights conveyed by a lease are consistent with the purposes for which the lands were acquired. For this analysis, it was hypothesized that any future mining operations authorized by such leases would be similar to mining operations on the nearby Viburnum Trend (Chapter One). Based on these hypotheses, specific mining activities were identified which might result if a lease or leases were issued.

Next, through public meetings and mailings, the public was invited to help identify issues associated with the proposed activities. Eight issues were identified: water quality; land character; lead market; national classified areas; jobs, economy and lifestyle; land use purpose; threatened and endangered species; and EIS schedule (Chapter One). In addition, the Bureau and Forest Service identified two management concerns: the compatibility of mining activities with the Forest Plan and the availability of land for mineral development.

The next step was to identify how existing laws and regulations pertained to the issues or concerns. In many cases, existing laws provide sufficient protection for the resource at issue or of concern. For example, both the public and Federal resource managers are concerned with the possible impact of mineral activities on water resources. Existing Federal and State laws require that prior to approval of any operations which could effect water quality, a detailed site evaluation, plan development and review process will be conducted. If it were found that the resource cannot be adequately protected, the activity as proposed would not be permitted. In cases where the law does not provide adequate protection, mitigating measures may be necessary.

In response to the issues and concerns raised during the comment period, five alternative responses to the lease application were developed. These alternatives range from maximum mineral development to maximum resource protection.

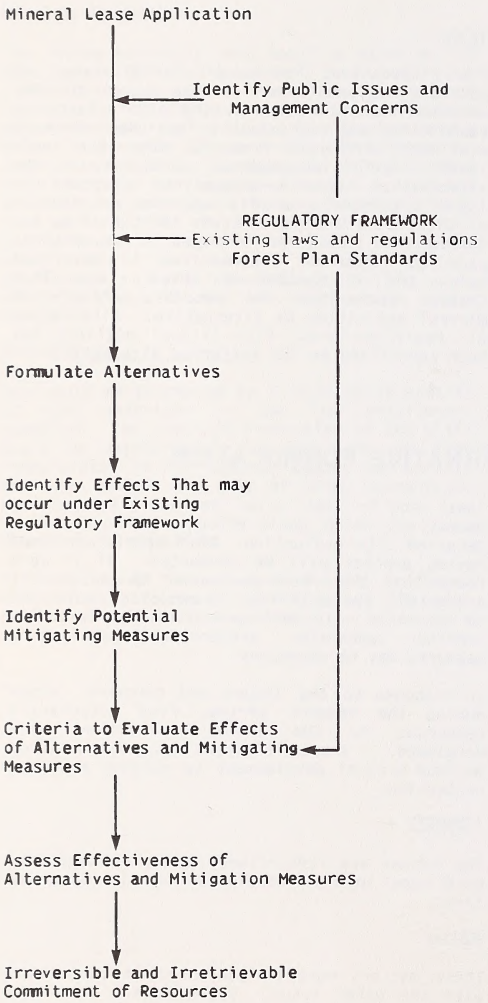
ISSUES

The issues are redescribed to explain how they were used in the formulation of the alternatives.

Water

Three matters must be addressed in connection with the water issue. Heavy Metals (such as lead, zinc, or copper) or milling reagents may leak into the natural waters of the study area as a result of mine tailings disposal, particularly if disposed of in impoundments similar to those in the Viburnum Trend. There is concern that such structures could not hold water because of the frequency of sinkholes and pond failures within or near the study area.

FIGURE 6
GENERAL PROCESS FOR FORMULATION OF ALTERNATIVES AND ASSESSMENT OF ENVIRONMENTAL EFFECTS



Source: USDA-Forest Service and Bureau of Land Management, 1987.

Mine shaft construction and mine dewatering may alter groundwater flows and levels. Further, a variety of activities may lower existing water quality. For example, sedimentation in area rivers and streams may result from drill site clearings and road and facility construction; drilling effluents or herbicides for powerline right-of-way maintenance may enter the water.

The issue of mine tailings disposal suggests a general ban on any mine waste disposal method that may fail or leak. Presently there are several options to the traditional tailings impoundment: such as stope backfilling, impoundment liners, below grade disposal of tailings, thickened discharge and off-site disposal (PEDCO. Environmental, Inc., 1984). The most appropriate method to be used on a given project must be based on site-specific technical and economic factors and therefore, cannot be determined at this time. These options will be analyzed if and when a mining proposal is received. However, to ensure that there is no undue risk of water quality degradation from impoundment leakage, every lease issued, regardless of which alternative is selected, will include the following stipulation:

> "Mine tailings impoundments will not be permitted within the lease area unless additional studies conclusively show that such facilities can be constructed in an environmentally sound manner. Any subsequent decision to approve tailings impoundments will be made by the Missouri Department of Natural Resources, Forest Service and the Bureau of Land Management. This decision will be based on study findings and the preparation of appropriate environmental documentation in compliance with the National Environmental Policy Act."

The groundwater and general water quality issues are addressed in terms of general effects in the summary of Environmental Consequences by Alternative.

Land Character

The issue regarding the natural character of the land suggests that mineral development activities be conducted in a way that would maintain the existing quality of the study area. Haul roads, mine/mill sites and powerlines tend to produce major modifications of the landscape. Options for reducing some of these impacts may include screening facilities from public view, or not permitting facilities near trails, roads or other areas of concentrated use. Further, mining activities may change land use patterns. Land use may be affected by increased populations or user pressure, increased traffic and noise, and increased demand for facilities and services.

Jobs, Economy and Lifestyle

The issue of economic and social change has two sides. One segment of the public does not want to change the local rural/recreation-related economy. They believe the effects of mining may change the area in such a way that recreation jobs may disappear. On the other hand, there are those who want mining jobs, community growth and the tax base to increase.

The no-lease alternative responds to the issue of maintaining existing recreation/service jobs and preserving the current lifestyle. The full lease alternative responds to the issue of creating additional jobs and tax revenue. The other alternatives seek a mix between mineral development and resource protection. They try both to preserve the recreation values and to permit mining.

Threatened and Endangered Species

This issue focuses on the idea that mineral activities could adversely affect threatened or endangered species. Any alternative selected must be in compliance with the Endangered Species Act, as amended.

Lead Market

There are two sides to this issue. Some people question the need for future lead resources. They believe that future demand will decline, that it can be met through conservation and recycling and that potential resources in the study area are not needed to meet future demands. Others see the need to develop these potential resources to assure a long-term stable domestic supply.

Land Use Purpose

This issue arises from questions about whether mineral leasing would be consistent with the purposes for which the National Forest lands were acquired. As required by the Weeks Act, any alternative selected must be consistent with the acquisition authority.

Areas of National Significance

The areas of national significance include the Eleven Point National Scenic Riverways, the Irish Wilderness, Excluded Lands, Cupola Pond and Greer Spring. To address this issue suggests alternatives that would require mineral activities to be conducted in a manner that would protect the recreation, aesthetic or unique values of these areas. The sight and sounds of mineral activities and facilities would reduce the quality of the user's experience. Further, mine waste disposal, road construction, site clearings and facilities construction may also affect the water quality of the rivers.

CONCERNS

Compatibility with Forest Plan

This management concern is that mineral activities may not be consistent with the Forest Plan. Each alternative therefore, will be evaluated as to its consistency with the Forest Plan. If the selected alternative is not consistent with the Forest Plan, the Plan must be amended before the alternative is implemented.

Land Availability for Mineral Development

This management concern is that areas of high mineral potential may not be available to ensure an uninterrupted domestic supply of lead and associated metals. Several alternatives have been established to respond in part to this concern. Varying areas available for mineral development are evaluated to assess both the effects of mining on the environment and the effects of the location and amount of land available for mineral development.

ALTERNATIVES

ALTERNATIVE A: NO LEASE

The purpose of this alternative is to provide the maximum resource protection for non-mineral resources within the study area. Hardrock mineral leases would not be issued and there would be no mineral development or production.

This alternative responds to the water quality, land character and national classified area issues. These resources and uses would not be affected by mineral activities because no activity would be permitted. However, this alternative does not respond to the concern that these lands should be available for mineral development and production, or to the issue of possible mineral related jobs or benefits to local economy.

Activities other than mineral leasing, such as routine timber harvesting, road construction and wildlife habitat management would occur as prescribed by the Forest Plan.

ALTERNATIVE B: FULL LEASING

The purpose of this alternative is to provide for the maximum amount of mineral development and production by applying the standard mining practices currently used in the Viburnum Trend (Chapter One, Potential Mineral Activities). Hardrock mineral leases would be issued and mineral activities would be permitted throughout the study area except in the Eleven Point Scenic River corridor. Resource protection would be prescribed as required by existing laws, regulations and policies. The water resource would be protected by the "no degradation" stipulation. Under this alternative, haul roads, transmission lines, mine waste disposal sites and mine/mill facilities would be permitted consistent with good manage-

ment practices. Under this alternative, mining would be considered as the high priority use for lands within the study area.

This alternative responds to the concern about availability of land for mining. However, implementation of this alternative could require a change in current Forest Plan direction. Depending on the location of needed mineral facilities, some Forest Plan standards may need to be changed. For example, visual quality standards may have to be changed to permit maximum modification for transmission corridors, haul roads, mine/mill facilities and impoundments. Further, implementation of this alternative may require redesignating management area 6.2 (11,354 acres) to a management area designation of 3.4. A discussion of management areas is included in Chapter Four, Alternative A - No Leasing. This change would permit an increase in road density and clearing size. Alternative B is shown in Figure 7.

ALTERNATIVE C: FOREST PLAN

The purpose of this alternative is to lease minerals and permit mineral development and production activities while maintaining existing water quality, current land character, protecting national classified areas and maintaining current Forest Plan direction. To comply with Forest Plan requirements, transmission corridors and mine waste disposal sites would be prohibited on nearly 80% of the area. Haul roads and mine/mill sites would be prohibited on 70% of the area. In addition, the construction of all roads would be restricted in the 6.2 Management Area (11,354 acres).

This alternative responds to the issue of preserving the land character and protecting the national classified areas by restricting mineral activities to those consistent with current Forest Plan direction. There are concerns that these restrictions unacceptably reduce the total area available for mineral activities and greatly increase the cost of operations in the event mining activities are proposed and approved.

Mineral exploration could continue to occur under this alternative. Development and production activities would occur only in those areas where Forest Plan visual standards permit maximum landscape modification. The mining industry is concerned that there would not be sufficient land available to develop or produce minerals. Alternative C is illustrated in Figure 8.

ALTERNATIVE D: MODIFIED FOREST PLAN (VISUAL QUALITY)

The purpose of this alternative is to increase the land available for mineral development and production activities while maintaining existing water quality, protecting areas of national significance and protecting threatened and endangered species and species habitat. Visual quality standards would be changed to permit mineral activities over a larger percentage of the area than Alternative C. There would be no change to the management of the 6.2 Management Area. Alternative D has been identified as the Preferred Alternative.

By changing the current Forest Plan visual quality standards, this alternative responds to the concern in Alternative C about land available for mineral activities and cost of operations. The changes, however, could permit activities to occur in areas that could alter the land character.

Visual quality standards (Forest Plan, page IV 31-36) would be changed to permit mineral activities in most of the area. However, to ensure protection of the most sensitive visual resources, the following restrictions would apply. Tailings impoundments will not be permitted within the seen area (usually up to one mile) of Highways 19, 99, J and K; Forest Roads 3152, 3174 and 3190; the Eleven Point River; and the Ozark and Blue Ridge Trails. Powerlines will not be permitted within the seen area of Highways 19, 99, and J; Forest Roads 3152, 3153, 3155, 3164 and 3169; the Eleven Point River; and Ozark and Blue Ridge Trails.

Further, powerlines will not be permitted within the foreground of Highway K or Forest Roads 3169, 3173 or 3174. Mill sites will not be permitted within the foreground of Highways 19, 99, J and K; Forest Roads 3152, 3155, 3164 3169, 3173 and 3174 nor within the seen area of Forest Roads 3153 or 3190; the Eleven Point River; and the Ozark and Blue Ridge Trails. In addition, haul roads will not be permitted within the foreground of Forest Roads 3153, 3155, 3164 and 3190; or the seen area of the Eleven Point River; and the Ozark and Blue Ridge Trails. The tailings impoundment restriction affects 60% of the study area, the powerline restriction 52%; the mill site restriction 50% and the haul road restriction 39%.

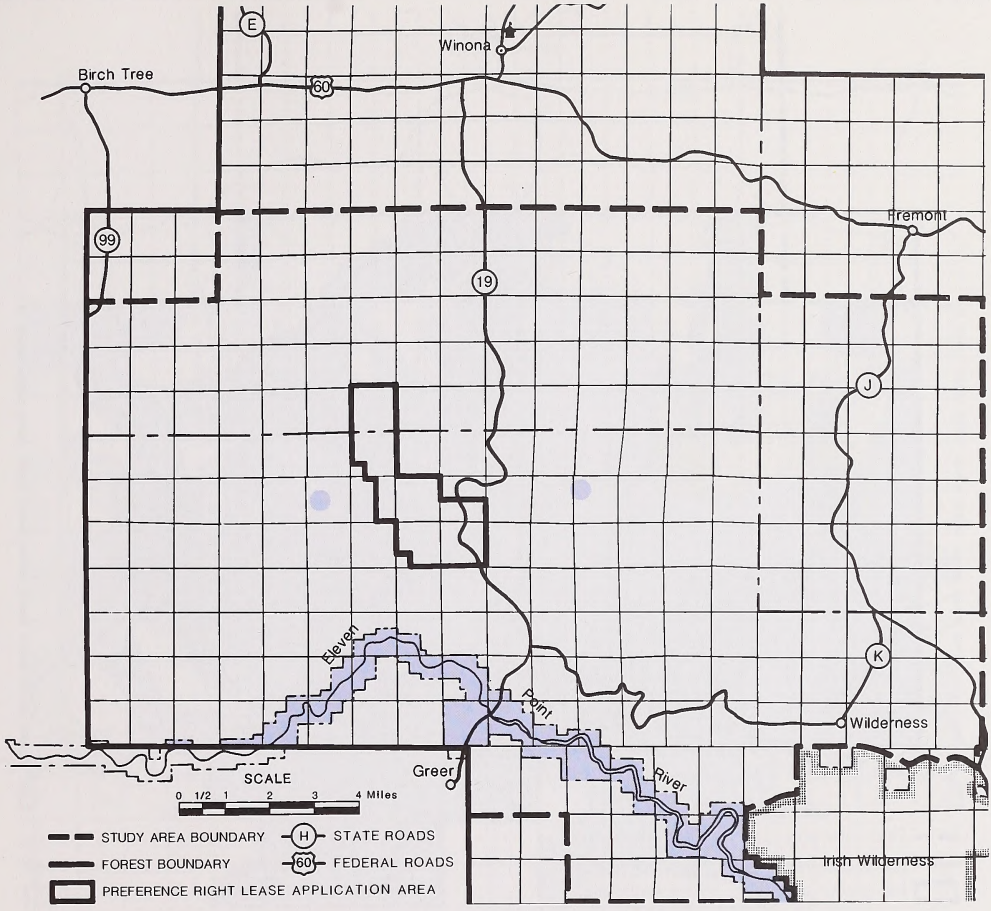
All other non-visual related Forest Plan standards would apply. Alternative D is illustrated in Figure 9.

ALTERNATIVE E: MODIFIED FOREST PLAN (VISUAL QUALITY AND 6.2 MANAGEMENT AREA)

The purpose of this alternative is to further increase the amount of land available for mineral development and production. This alternative combines the changes in visual quality standards of Alternative D with increased road density and clearing standards from those specified in Management Area 6.2. Under this alternative 11,354 acres (9% of the study area would be redesignated to a management area 3.4. This alternative provides the same protection for water, areas of national significance and threatened and endangered species and habitat.

If this area is redesignated, 64,101 acres (54% of study area) would be in a 3.4 Management Area. The Forest Plan indicated that up to

Figure 7: ALTERNATIVE B - FULL LEASING



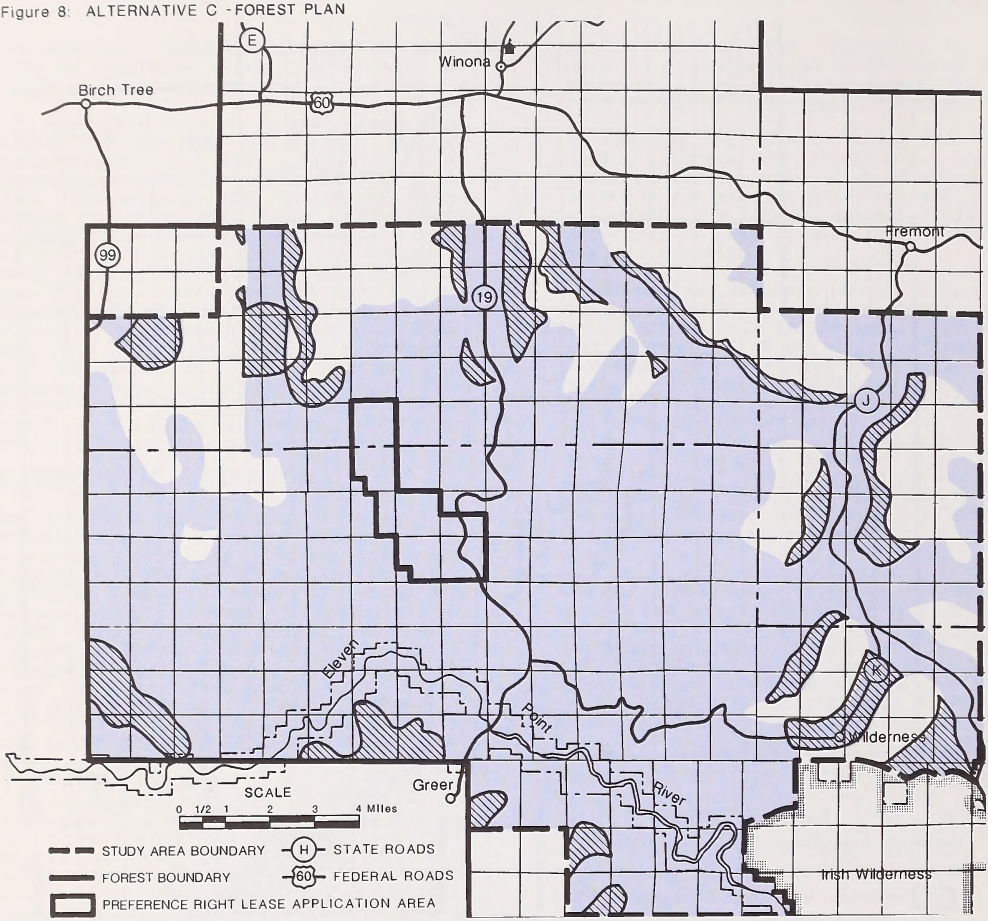
LEGEND

Tailings impoundments, transmission corridors, mine/mill facilities and haul roads not permitted

HARDROCK MINERAL LEASING
U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE

MARK TWAIN NATIONAL FOREST–MISSOURI
U.S. DEPARTMENT OF INTERIOR • BUREAU OF LAND MANAGEMENT

Figure 8: ALTERNATIVE C -FOREST PLAN



LEGEND

Tailings impoundments, transmission corridors, mine/mill facilities and haul roads not permitted

Tailings impoundments and transmission corridors not permitted

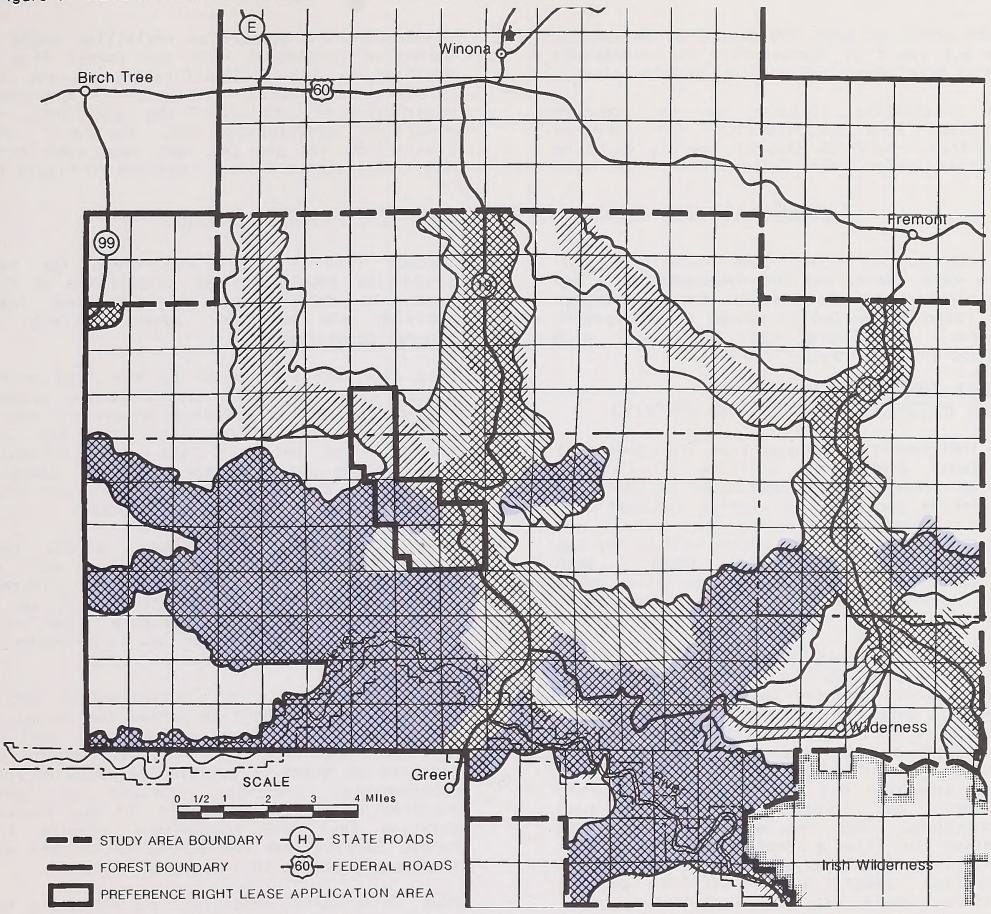
HARDROCK MINERAL LEASING

U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE

MARK TWAIN NATIONAL FOREST-MISSOURI

U.S. DEPARTMENT OF INTERIOR • BUREAU OF LAND MANAGEMENT

Figure 9: ALTERNATIVE D - MODIFIED FOREST PLAN (VISUAL QUALITY)



LEGEND

Tailings impoundments not permitted

Transmission corridors not permitted

Mine/mill facilities not permitted

Haul roads not permitted

HARDROCK MINERAL LEASING

U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE

MARK TWAIN NATIONAL FOREST–MISSOURI

U.S. DEPARTMENT OF INTERIOR • BUREAU OF LAND MANAGEMENT

26,580 acres of area designated as Management Area 6.2 could be reclassified to accommodate mineral development and production activities.

This alternative responds to the concern regarding land availability for mineral activities. Hardrock mineral leasing would be permitted under this alternative. Mineral development and production activities would be permitted consistent with the Forest Plan as modified by the reclassification of the 6.2 management area. Tailings impoundment restriction affects 57% of the study area, the powerline restriction 49%, the mill site restriction 47% and the haul road restriction 36%. Alternative E is illustrated in Figure 10.

ALTERNATIVES ELIMINATED FROM DETAILED STUDY

Two alternatives other than those discussed above were identified and subsequently. They were eliminated from detailed study. Although they responded to public issues and management concerns, they were not consistent with existing laws and regulations.

PERMIT FURTHER EXPLORATION UNDER EXTENDED PROSPECTING PERMITS

Some individuals and groups have indicated that additional exploratory drilling on the two pending lease applications under an extended prospecting permit would provide substantially more information regarding the size and location of mineable ore bodies within the two pending lease application areas. Such information would permit the completion of a more detailed, site-specific environmental analysis.

This alternative was eliminated from further study because previous prospecting permit extensions were granted and have expired. The Bureau has determined the permittee discovered a valuable mineral deposit on the area encompassed by the two lease applications. Prospecting activities are not permitted when a permit extension has expired and a valuable discovery has been made. In such circumstances, the regulations require the permittee to file a preference right lease application. The alternative to allow further exploration under a prospecting permit, therefore, could not be implemented under existing Bureau regulations.

POSTPONE OR DENY LEASING UNTIL LEAD MARKET CONDITIONS IMPROVE

Some individuals and groups have indicated that due to current lead market conditions and present lead reserves, new areas for lead production should not be established at this time. A delay would postpone the lease decision and potential adverse effects of mineral development.

This alternative responds to the lead market issue raised by some individuals and groups. They contend that the Federal Government should not lease more Federal lands when the lead industry can not sell the lead presently mined. They go on to ask "Why risk damaging the Current and Eleven Point Rivers and other resources when we don't need the lead?"

Industry on the other hand, argues that exploration and development drilling must be done now. They further argue that Viburnum Trend reserves will be depleted in 10 to 15 years and given mine start-up time, new reserves must be delineated now to maintain an uninterrupted flow of lead.

This alternative is not considered in detail because a lease cannot be denied due to market conditions. Whether or not a lease will be profitable, or whether or not lead should or needs to be mined is outside the scope of this environmental analysis. Further, a lease decision cannot be postponed for any reason. Existing laws and regulations require the Forest Service and the Bureau to process all lease applications to a decision.

Thus, while market conditions are not among the statutorily authorized criteria for denying a lease, they do appear in the overall economic picture, and economic issues, including existing and future lead market conditions, will be considered in the final decision. The effects of denying the lease are discussed in Chapter Four under the No Lease Alternative.

SUMMARY OF ENVIRONMENTAL CONSEQUENCES BY ALTERNATIVE

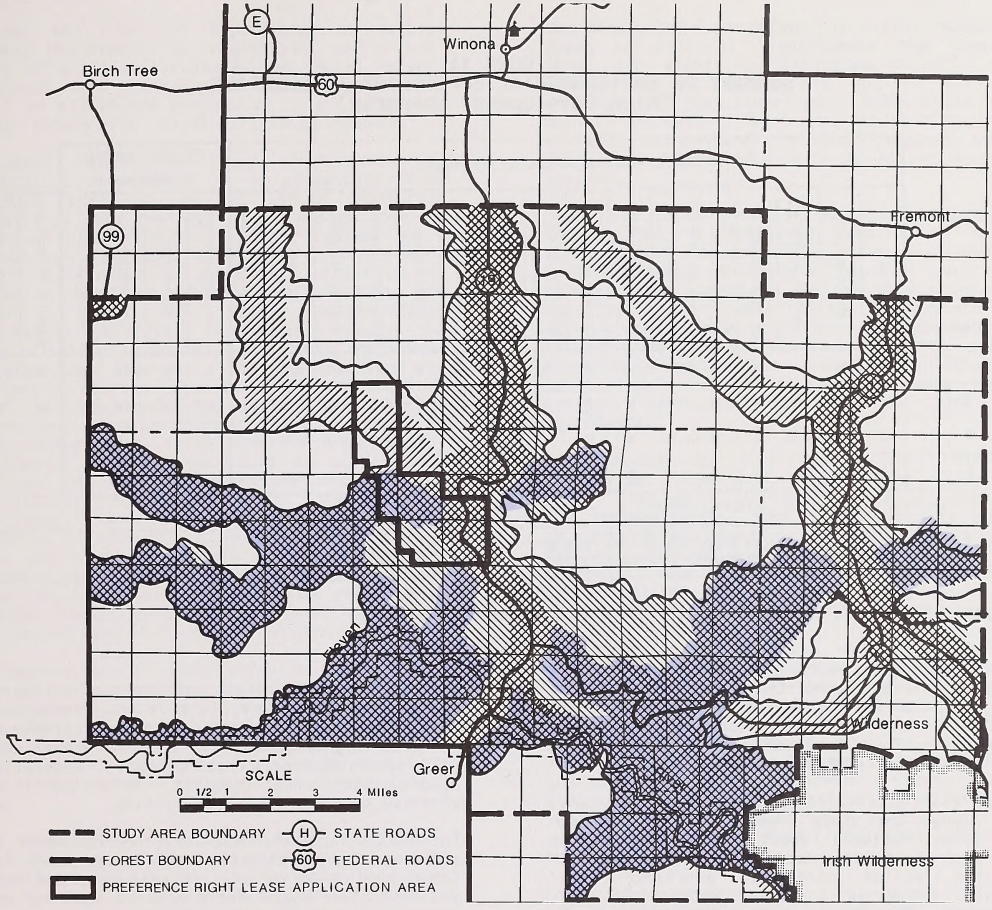
The following is a summary of the probable environmental consequences anticipated to result from the alternatives. A full and detailed analysis can be found in Chapter Four, Environmental Consequences. In order to evaluate the maximum possible impacts, these summaries assume the occurrence of activities of the high development scenario discussed in Chapter One. A summary of the environmental effects by alternative is contained in Figure 11.

Alternatives B, C, D and E may permit full mineral development (up to an estimated 3,400 acres), however, the alternatives vary by the amount and location of land area available for surface occupancy. Further, the implementation of some alternatives would require an amendment to the Forest Plan. Table 1 summarizes land availability by alternative.

ALTERNATIVE A: NO LEASE

Implementation of this alternative would not result in any effects to the environment from mineral activities because no mineral development activities would be permitted. However, there would be a variety of effects from

Figure 10: ALTERNATIVE E - MODIFIED FOREST PLAN (VISUAL QUALITY AND 6.2 MANAGEMENT AREA)



LEGEND

Tailings impoundments not permitted

Transmission corridors not permitted

Mine/mill facilities not permitted

Haul roads not permitted

HARDROCK MINERAL LEASING

U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE

MARK TWAIN NATIONAL FOREST-MISSOURI

U.S. DEPARTMENT OF INTERIOR • BUREAU OF LAND MANAGEMENT

FIGURE 11
SUMMARY OF ENVIRONMENTAL EFFECTS BY ALTERNATIVE
(High Development Scenario)

	PHYSICAL AND BIOLOGICAL ENVIRONMENT																	SOCIOECONOMIC ENVIRONMENT					
ALTERNATIVES	SOILS	WATER QUALITY	WATER QUANTITY	FLOODPLAINS	WETLANDS	AIR QUALITY	VISUAL RESOURCES	CULTRAL RESOURCES	AREAS OF NATIONAL SIGNIFICANCE	SPECIAL AREAS	RECREATION	VEGETATION	TERRESTRIAL WILDLIFE	AQUATIC WILDLIFE	CAVES	THREATENED AND ENDANGERED SPECIES	LAND CHARACTER	ECONOMICS	SOCIAL	MINING INDUSTRY	SUMMARY OF EFFECTS	CUMULATIVE EFFECTS
B	U	U	P/U	U	N	M	U	M	U	U	U	U	M/U	M/U	M/U	U	U	P	P/U	P	U	U
C	U	U	P/U	U	N	M	M	M	N	N/U	M	U	M/U	M/U	M/U	M/U	U	P	P/U	U	U	U
D	U	U	P/U	U	N	M	M	M	M	N/U	M	U	M/U	M/U	M/U	M/U	U	P	P/U	P/U	U	U
E	U	U	P/U	U	N	M	M	M	M	N/U	M	U	M/U	M/U	M/U	M/U	U	P	P/U	P/U	U	U

KEY : U - UNMITIGATED EFFECT; M - MITIGATED EFFECT ; N - NO EFFECT ; P - POSITIVE EFFECT

NOTE : SUMMARY OF EFFECTS ARE THOSE EFFECTS RESULTING FROM MINERAL ACTIVITIES.
CUMULATIVE EFFECTS ENCOMPASS MINERAL-RELATED ACTIVITIES PLUS FOREST PLAN ACTIVITIES.

Source: USDA-Forest Service and Bureau of Land Management, 1987.

routine management activities occurring in the study area under authority of the Forest Plan. Although these activities are outside the scope of this analysis, their effects are discussed because they form the basis for comparing the cumulative effects of the other alternatives.

Forest Plan activities over the next 10 years will change the study area. These activities will direct National Forest System lands toward the desired future conditions of increased wildlife habitat diversity; shortleaf pine forests; motorized dispersed recreation; and protection of special recreation, cultural or historic sites. (These management goals are described in the Forest Plan and EIS.) Specifically, from 50 million to 80 million boardfeet of timber will be cut and over 230 miles of roads will be constructed, reconstructed or maintained. This will directly affect nearly 15,000 acres of National Forest land.

These activities will affect the physical and biological resources within the study area. Clearings and roads will increase the natural erosion rate particularly during operations. These activities may affect water quality if the eroded soil enters surface streams or groundwater recharge areas. Floodplains may be affected because of road crossings; however, wetlands will be avoided and should not be affected. Air quality will be affected by fugitive dust and smoke from prescribed burns; however, these effects will be within State standards. Visual resources will be minimally affected because only activities consistent with long-term aesthetic objectives will be permitted within sight of sensitive travel routes or use areas. Cultural resources, threatened and endangered species, areas of national significance and special areas will not be adversely affected. Recreation opportunities, and wildlife habitat will be enhanced by these forest activities.

The Social and economic environment would be affected. Land character will be enhanced for those seeking a variety of resources and uses and possibly reduced for those not wanting any change.

Alternative A would significantly affect the lead mining industry by precluding potential mineral development and production from one of the most promising areas in the country. Not permitting the development of potential resources would result in jobs and income foregone. Potential returns to the U.S. Treasury and payments to affected counties would not be realized. The magnitude of these effects is uncertain. Alternative A would not result in a significant threat to the security of lead supplies to the U.S.

The cumulative effects of implementing this alternative are summarized in the Forest Plan.

ALTERNATIVE B: FULL LEASING

Implementation of Alternative B would result in changes to the physical and biological environment by a reduction in soil productivity; the possible decline in subsurface water levels; a loss of floodplains or wetlands; an increase in particulates released to the atmosphere; the possible disruption of historic or archeologic

sites; the loss or degradation of special areas; the removal of vegetation; and disruption of existing lifestyles and social values. Although such changes will occur, the effects will be eliminated or reduced to an acceptable level through the use of mitigating measures.

Resource changes may occur which cannot be eliminated or reduced to an acceptable level through the use of mitigation measures. Inspite of good engineering and design there is a potential for either chronic leakage or a catastrophic collapse of a tailings impoundment which would result in an adverse effect to the water resource. A change in water quality and quantity could also affect water-related recreation activities; terrestrial, aquatic and cave wildlife (including numerous threatened or endangered species), land character, and the recreation/tourism economy. It is possible that tailings and mine water clarification impoundments could improve water quantity by regulating flows. The visual resources or aesthetics of the area would be affected by changes in land patterns and placement of structures incongruent with the natural landscape. Areas of national significance would be affected by changes in adjacent land uses and patterns as well as the introduction of noise and human disturbance. Recreation and land character would similarly be effected by changes resulting from operational activities and an increase in local populations.

Implementation of Alternative B would affect the social and economic environment, resulting in an increase in local employment and income as well as additional dollar returns in the form of royalties to the Federal government and profit to the mineral industry. Implementation would require a major revision of the Forest Plan.

The cumulative effects of high development activities and Forest Plan activities would result in a significant risk of degrading water quality, loss of soil productivity and possible impacts to special areas and areas of national significance. Further, it would change the land character.

ALTERNATIVE C: FOREST PLAN

Alternative C does not permit mineral production activities to occur near visually sensitive travel routes or use areas. Therefore, with the exception of exploration, mineral activities would be concentrated in the northeastern portion of the study area (approximately 24,000 acres).

These activities could affect the physical/biological environment by removing over 3,000 acres from timber production and possibly affecting productivity of additional acres due to drilling effluent disposal, fugitive milling dust, tailings leakage and vent shaft/transportation exhaust fumes. These activities could affect floodplains, depending upon the location of roads and tailings impoundments. Because the activities are located away from sensitive travel routes and use areas, possible effects to visual resource, areas of national significance and special areas can either be mitigated or will not occur. Any effects to air quality will be minimized through compliance with State air quality standards. There will be no effects to wetlands or cultural resources because these areas will be surveyed prior to activities and avoided.

There are three types of potential effects on water. One is localized impacts to water quality due to petroleum, sanitary sewage, milling reagent, drilling effluent or herbicide spills. The magnitude of the effect depends upon the amount of material spilled and whether it reaches surface or groundwater systems. It is possible that these contaminants could temporarily reduce water quality. Petroleum spills would have the greatest long term impacts, particularly if they got into the groundwater.

In addition to localized spills, mineral activities could disturb over 3000 acres of land. This would increase the risk of erosion and sedimentation. Most of the impacts would be reduced by employing mitigating measures. Further, because activities would be in the northeast, away from the major surface streams, it is unlikely that sediment would reach the most sensitive recreation and fishery streams.

The greatest risk to both water quality and quantity would result from either chronic leakage or a catastrophic collapse of a tailings impoundment. If this occurred, it could load both the surface and subsurface systems with thousands of yards of tailings. This could choke stream bottoms, change surface channels and alter groundwater flows. Such discharges would directly affect water-related recreation activities as well as terrestrial, aquatic and cave wildlife (including numerous threatened and endangered species).

Conversely, tailings and mine water clarification impoundments may improve water quantity by regulating flows.

Activities permitted under Alternative C would also affect the social/economic environment. A mine/mill complex would change land character. For some, this would reduce tourism by visitors expecting the "naturalness" from the area. For others, the change would improve the area by providing mining jobs and increasing the tax base.

This alternative could greatly increase the cost of mining operations if the ore body were located beneath lands unavailable for surface occupancy. For example, if the ore body were located in the southwestern part and mine/mills were only permitted in the northeast, the company would have to transport the ore from a mine to a remotely located mill. This, along with the associated increase in capital costs, might make operations economically infeasible.

The cumulative effects of mining activities and Forest Plan projects would increase the risk of

degrading water quality, water-related uses and land character. There is an increased risk of affecting the visual/recreation quality of the special areas of national significance, frequent travel routes and the Eleven Point River.

Implementation would require a revision of the Forest Plan visual quality standards.

ALTERNATIVE D: MODIFIED FOREST PLAN (VISUAL QUALITY)

The effects of implementing Alternative D would be similar to Alternative C except that there would be an increased risk of affecting visual resources along sensitive travel routes and use areas. This could occur because Forest Plan quality standards would be change to permit haul roads, mine/mill sites, vent shafts and mine water clarification impoundments close to roads, highways areas of national significance, special areas, the Ozark and Blue Ridge Trails and the Eleven Point River. Tailings impoundment and powerline restrictions would remain the same as Alternative C.

The effects of Alternative D on water quality and quantity are the same as those previously described for Alternative C.

This alternative could increase the cost of mining operations if the ore body were located beneath lands unavailable for occupancy. However, more of the study areas is available for mineral development than under Alternative C. Therefore, haul road costs, though high, are lower than those projected under Alternative C.

The cumulative effects of mining activities and Forest Plan projects would increase the risk of degrading water quality, water-related uses and land character. There is an increased risk of affecting the visual/recreation quality of special areas of national significance, frequent travel routes and the Eleven Point River.

Implementation would require a revision of the Forest Plan visual quality standards and the redesignation of the 6.2 management area to a 3.4 management area.

ALTERNATIVE E: MODIFIED FOREST PLAN (VISUAL QUALITY AND 6.2 MANAGEMENT AREA)

The effects of implementing Alternative E would be the same as Alternative D except that the Forest Plan road density restriction for the 6.2 management area (11,354 acres) would be changed from one mile per square mile to two miles per square mile. This is the same road density for all other management areas in each of the other alternatives. This change is consistent with the Forest Plan.

These activities could affect the physical and biological environment by removing over 3,000 acres from timber production and possibly affecting productivity of additional acres due to drilling effluent disposal, fugitive milling dust, tailings leakage and vent shaft/transportation exhaust fumes. These activities could affect floodplains, depending upon the location of roads and tailings impoundments. Because the activities are located away from sensitive travel routes and use areas, possible effects to visual resources, areas of national significance and special areas can either be mitigated or will not occur. Any effects to air quality will be minimized through compliance with State air quality standards. There will be no effects to wetlands or cultural resources because these areas will be surveyed prior to activities and avoided.

The effects of Alternative E on water quality and quantity are the same as those previously described for Alternative C. Alternative C would increase slightly the amount of land available for mineral activities above that of Alternative D.

The cumulative impacts of mining activities and Forest Plan projects would increase the risk of degrading water quality, water related uses and land character. The special areas, visual quality, wildlife habitat (except from a tailing accident) would not be affected.

CHAPTER THREE

DESCRIPTION OF AFFECTED ENVIRONMENT

INTRODUCTION

This chapter briefly describes the physical, biological, economic and social environments of the study area. This description focuses on the environment affected by the alternatives identified in Chapter Two. The level of the discussion contained in this chapter is commensurate with the nature of anticipated effects. Those resources with less important effects are summarized or simply referenced.

The description of the affected environment generally coincides with the study area boundary. Some discussions include adjacent areas. These discussions consist of national significance, social environment and economic environment.

This Chapter and Chapter Four are organized in the same manner. This organization also parallels that of the Forest Plan.

PHYSICAL ENVIRONMENT

SOILS, MINERALS AND GEOLOGY

The study area lies in the Salem Plateau of the Ozark Physiographic Province. The region is a maturely dissected, rolling upland surface underlain by rocks of lower Paleozoic age. Study area elevations range from approximately 500 feet along the Eleven Point River to 1080 feet in the northwestern corner. The area is dissected by numerous streams with major drainage provided by the Eleven Point and Current Rivers. These rivers and their tributaries have cut v-shaped valleys hundreds of feet deep. Some ridge tops are broad, but the majority are narrow. Slopes are moderate to steep.

The predominant soil parent material (residuum) on the uplands is from the Roubidoux Formation. This residuum contains blocks of sandstone and chert fragments. The bottomlands contain alluvial and colluvial soils from eroded residuum of the Roubidoux and Gasconade Formations.

Exposed rocks within the study area are confined to the Gasconade, Roubidoux and Jefferson City Formations, all are of lower Ordovician age. Outcroppings of the Gasconade Formation are limited to the lowest elevations along the major drainage valleys, while the Roubidoux and Jefferson City Formations are exposed elsewhere in the area. The stratigraphic succession beneath the Gasconade Formation consist of approximately 1500 feet of sedimentary carbonates, shales and sandstones lying on an erosional surface of Precambrian crystalline rock.

SOILS

There are three general types of land forms in the study area: broad, relatively flat ridges; narrow ridge tops with steep side slopes; and bottom lands.

The broad, relatively flat ridges have the Captina, Macedonia, Doniphan and Wilderness soil series. These soils consist of deep loam and clay capped with loess (wind-blown silty material). The soils are moderately well to well drained, moderately to slowly permeable, moderate to low in available water capacities and low in fertility. They erode at slight to moderate rates and compact easily in wet weather. They recover from disturbance slowly due to their low nutrient content and clayey subsoil.

The narrow ridge tops and steep to very steep side slopes have Clarksville, Coulstone and Poynor soils. These soils are formed in the residues of cherty dolomite and sandstone. They are excessively drained, rapidly permeable and low in fertility. Due to their high chert content, they are only slightly to moderately erosive and compactable. They recover quickly after disturbance if fertilized.

Another steep sideslope soil is the Opequon. It occurs near drainageways in the highly dissected areas. These areas are similar to glades. Most of the areas are open or have a thin cover of plants. The soil material is generally less than 15 to 20 inches deep. Available water capacity is medium.

There are several bottomland soils. Ashton and Newark soils form on silty alluvium in sink bottoms. These soils are well to somewhat poorly drained, moderately permeable, moderate to high in water capacity, moderately erosive and highly compactable when wet. Midco soils are deep and cherty occupying narrow stream bottoms. They are excessively drained, highly permeable, low in available water capacity, slightly erosive and moderately resistant to compaction. The Ashton and Secesh soils occupy wide bottomlands forming of low stream terraces. They are well drained and are the best soils in the area for cultivation and high-value tree species. They are easily compacted when wet.

Stratigraphy

Stratigraphy in the study area as displayed in Figure 12, a composite stratigraphic column representing the rocks encountered within the area. The Jefferson City Formation consists chiefly of light brown to brown, medium to finely crystalline dolomite and clayey dolomite (Martin et al. 1961). Within the area, the Jefferson City Formation has limited surface exposure, confined to the upper elevations at the western and southern study area boundaries. This formation has an average thickness of 200 feet.

The Roubidoux Formation is composed of sandstone, dolomitic sandstone and cherty dolomite. Most of the study area falls within the outcrop belt of the Roubidoux. The formation attains an average thickness within this zone of 200 feet.

The Gasconade Formation is a cherty, gray dolomite with the amount of chert decreasing toward the surface. The dolomite is coarse crystalline in the lower section of the formation, but grades into a fine crystalline in the upper part. This formation averages 300 feet in thickness within the central Ozarks (Martin et al., 1961).

The Eminence Formation is the youngest unit of the upper Cambrian in southeast Missouri. Like the Potosi Formation, the Eminence is a massively bedded dolomite with abundant cavities.

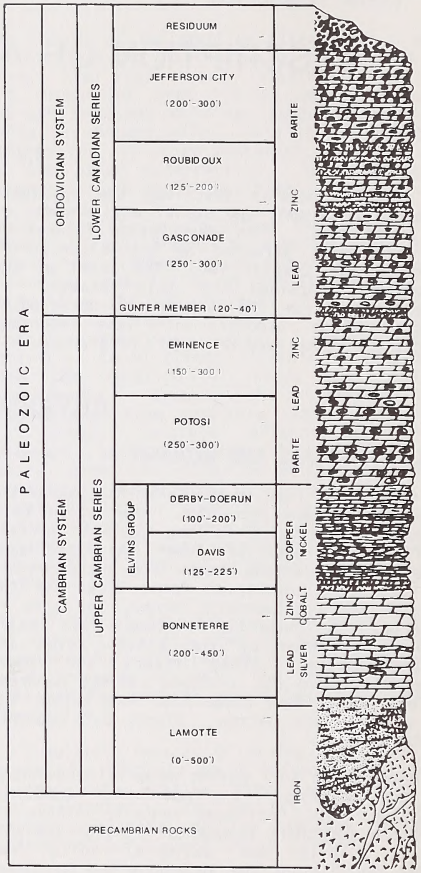
The Potosi Formation is a massively bedded, tan dolomite. While the lowermost section of the Potosi is transitional with the underlying Derby-Doerun and is often silica free, the upper Potosi is characterized by abundant clusters of quartz crystals in holes or cavities.

The upper Cambrian Elvins Group consists of the Derby-Doerun Formation and the Davis Formation. The Derby-Doerun Formation is a fine to medium crystalline dolomite with many shale partings. The Derby-Doerun averages approximately 150 feet in thickness state-wide. Drill logs indicate this formation to be around 120 feet thick within the study area.

The Davis Formation is composed of shales, siltstone fine-grained sandstone and carbonates. In southeast Missouri, this formation is predominately shale and limestone or shale and dolomitized limestone.

The Bonneterre Formation is the host rock of the principal lead-zinc deposits of southeast Missouri. It is primarily a dolomite, but can grade to a limestone in relatively short lateral distances. The physical character of the Bonneterre lithology varies as a result of the depositional environments during late Cambrian times. The resulting facies in the formation correspond to the water depth and energy level of that particular paleo-environment. Like the Lamotte sandstone

FIGURE 12
COMPOSITE STRATIGRAPHIC COLUMN



Source: Missouri Department of Natural Resources, 1986.

it overlies, the Bonneterre can be absent from areas around the Precambrian topographic highs.

The Lamotte sandstone is the basal formation overlying the Precambrian surface except in areas where knobs rising from the basement have caused it to thin and pinch out. It is a quartzose sandstone typically white or light gray. The lowermost section generally consists as a conglomerate of weathered Precambrian material and boulders.

The Precambrian formations of southeast Missouri are composed of a variety of igneous rocks. The surface was subjected to intense erosion prior to the deposition of the upper Cambrian sediments resulting in a paleotopography of pronounced ridges, isolated peaks, broad basins and steep walled valleys.

GEOLOGIC STRUCTURE

The study area lies in southeast Missouri which is part of the stable cration of the United States. By "stable" it is meant that no orogenesis or mountain-building processes have occurred since Precambrian times (G. Kisvarsonyi, 1977).

The predominant structural feature of the region is the Ozark Uplift which trends through southeast Missouri in a south-southeasterly direction. The St. Francois Mountains, lying approximately 50 miles to the northeast of the study area, are highland masses of Precambrian igneous rocks which form part of the core of the Ozark Uplift. The St. Francois Mountains cause overlying formations on its flanks to dip away concentrically from it. Consequently formational dips within the study area trend south-southwest. There are no documented faults or folds within the study area.

REGIONAL MINERALIZATION

For years, it has been recognized that the lead-zinc concentrations of southeastern Missouri are strongly related to specific depositional facies and structures in the Bonneterre Formation, the principal ore host rock in the area. The ores are Mississippi Valley-type sulfides disseminated throughout favorable zones, forming replacements of the pre-existing carbonates. The ore bodies are characteristically sporadic, varying greatly in width, thickness and grade.

The geologic controls on ore localization were provided by Precambrian rock protrusions from the late Cambrian sea floor, which created islands and shoals. Algal reefs grew along the islands and shoals in response to the higher light levels and higher current velocities, which may have enhanced nutrient availability.

The mineralization is usually found to be associated with the algal reef structures fringing the Precambrian paleotopographic highs. Mineralization resulted from circulation of warm brines through the porous reef structures after burial. The brines probably originated during the compaction and dewatering of metalliferous shales in deep parts of basins to the south and east, but the mechanisms involved in transporting the brines is not yet certain. It seems likely from recent studies that the Devonian through Pennsylvanian tectonic activity that resulted in the Appalachian and Quachita uplift caused pulses of basin brines to move through existing aquifers to the sites of mineralization, but the exact hydrological and geochemical processes involved are still under scrutiny.

KARST TERRAIN

The study area lies in a region of well developed karst terrain. Karst denotes a terrain that is formed in carbonate or other readily soluble rock, and is typically characterized by caves, sinkholes and underground drainages.

Mildly acidic water is the primary agent in the formation of karst terrain. Almost all surface and groundwater becomes slightly acidic after precipitation, due to the presence of carbon dioxide in the air and homic acids from the breakdown of vegetative materials. Surface and groundwater follow existing joints and other zones and weaknesses in the carbonate rock, slowly expanding them by solution.

Conditions favorable for the development of karst terrain are present throughout the Ozarks and these include: a humid climate where limestone or other soluble rocks are at or near the surface, plentiful rainfall, carbonate rocks which are well jointed and the occurrence of carbonate rocks above the streams in the region.

Although the study area has a highly developed karst terrain, there is a marked absence of the classic features which usually identify such terrain. For example, here sinkholes are not numerous and the overburden is relatively thick. Regionally, the area consists of deeply weathered, highly permeable residual soil, underlain by massive, cavernous dolomite and dolomite-sandstone (Williams and Vineyard, 1976).

WATER RESOURCES

Water Quantity

Based on 42 years of records from Alton and 76 years from Birch Tree (U.S. Dept. of Commerce), average annual precipitation in the study area is 44 inches. May is the wettest month, averaging five inches of precipitation and January or February are the driest, averaging 2-1/2 inches.

Regionalized U.S. Geological Survey data (Gann, et al., 1976) indicate that average annual surface water yield should be about 15 area-inches. Actual surface water yield, however, is substantially less. For example, near the center of the area, flow occurred in Hurricane Creek at the Highway 19 bridge (drainage area 56 square miles) on only 39 of the 1,461 days during water years 1969-72 (USDA-Forest Service). Near the mouth of Hurricane Creek where the drainage area is 113 square miles, 8 years of continuous gaging records indicate an average annual surface water yield of only about 2.8 area-inches (USDA-Forest Service). These data imply the loss of a large amount of surface water to the groundwater system.

Except for the Eleven Point River, other area streams have surface water yields similar to that of Hurricane Creek. Spring Creek, Big Barren Creek, all of the Pike Creek tributaries, and all of the smaller tributaries to the Eleven Point River lose most of their surface water to the groundwater system. Year-round streamflow is limited to the Eleven Point River, spring branches and tributary mouths near the Eleven Point base level, Greer Spring branch, and very short spring-fed reaches above channel-bottom flow-loss points in other tributary streams (Figure 13). Table 6

Figure 13: PERENNIAL STREAMS IN EIS STUDY AREA REGION

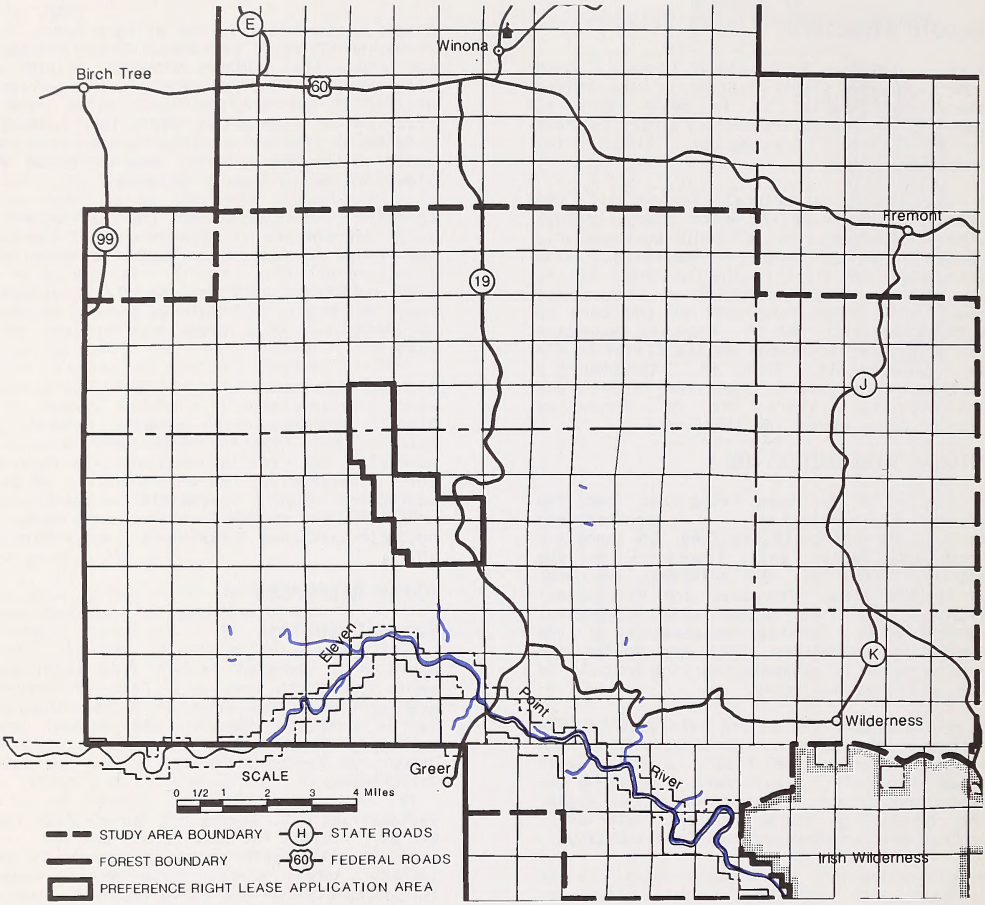


TABLE 6
STREAMFLOW DATA LOCATIONS

Location	Kind of record	Agency 1/	Average annual flow 2/ (cfs)	2-year low flow 3/ (cfs)	10-year low flow 3/ (cfs)	50-year low flow 3/ (cfs)
Eleven Point River at Thomasville	Occasional measurements, 1942-82	G, F	-	0.3	0.04	0.01
Middle Fork Eleven Point River at Thomasville	Occasional measurements, 1951-82	G	-	1.3	0.6	0.3
Eleven Point River near Thomasville	Continuously gaged, 1951-76	G	101	7.2	4.1	2.7
Posey Spring	Occasional measurements 1950-69	G	-	0.6	-	-
Spring Creek near Thomasville	Occasional measurements, 1969-70	G	-	0.0	0.0	0.0
McCormack Spring near Greer	Continuously gaged, 1965-75; other measurements	G, F	1.7	0.2	0.07	-
Eleven Point River at Greer Spring	Occasional measurements 1969-81	G, F	-	30	14	10
Greer Spring near Greer	Continuously gaged, 1922-86	G	338	184	122	100
Huff Springs Group	Occasional measurements, 1947-80	G, F	25	20	18	-
Hurricane Creek near Winona	Continuously gaged 1969-72	F	-	0.0	0.0	0.0
Falling Spring near Greer	Continuously gaged, 1967-75; other occasional measurements	G, F	0.7	0.1	0.06	-
Hurricane Creek near mouth	Continuously gaged, 1966-75	F	24	2.5	1.2	-
Turner Mill Spring near Wilderness	Continuously gaged, 1968-74; other occasional measurements	G, F	11	2.6	1.7	-
Eleven Point River near Bradley	Continuously gaged 1922-86	G	769	270	185	150
Eleven Point River from Thomasville to Highway 142	Low-flow seepage run October 14-17, 1968	G		-	-	-
Pike Creek at Van Buren	Occasional measurements, 1967-80	G, F	-	1.8	1.1	0.8

TABLE 6 (Continued)

Location	Kind of record	Agency 1/	Average annual flow 2/ (cfs)	2-year low flow 3/ (cfs)	10-year low flow 3/ (cfs)	50-year low flow 3/ (cfs)
Big Spring near Van Buren	Continuously gaged, 1922-86	G	441	290	254	240
Phillips Spring near Grandin	Occasional measurements, 1925-84	G, F	29	12	8	-
Big Barren Creek near Bennett	Occasional measurements, 1978-84	F	-	Less than 0.5	-	0.0
Twin Springs near Bennett	Occasional measurements, 1946-84	G, F	-	5	2	-
Tucker Spring near Bennett	Occasional measurements, 1946-84	G, F	40	30	26	-

1/ G = U.S. Geological Survey; F = U.S. Forest Service.
2/ All annual- and low-flow estimates are from Skelton (1976), U.S. Geological Survey (1976 and 1985), or from unpublished Forest Service analyses.
3/ Low flows are the average minimum flow for seven consecutive days for the indicated recurrence intervals.

Source: U.S. Geological Survey and USDA-Forest Service, various years.

provides a listing of flow-data locations in and near the area.

The large disparity between the amount of surface water expected in the area and the amount actually there is related to the area's intensely developed karst terrain. Many years of surface water flow monitoring and surface-to-groundwater tracing with fluorescein dye and Lycopodium spores indicate that most of the area's water appears as groundwater discharge from Big Spring on the Current River, and as diffuse inflow and discharge from many springs along the Eleven Point. In addition, groundwater from at least part of the Big Barren Creek headwaters may discharge from Phillips Spring on the Current River, and it's remotely possible a small portion of the area may help recharge Twin and Tucker Springs on the Current River (Figure 14).

Precipitation and surface water enter into and move through the groundwater system in a variety of ways. At one extreme is slow, diffuse seepage through soil, residuum and bedrock. The rate at which diffuse seepage travels is uncertain, but (Aley 1975) at times its vertical passage from the surface to the zone saturated in weeks and months. Once in the saturated zone, at least some of the water can stay there for many years.

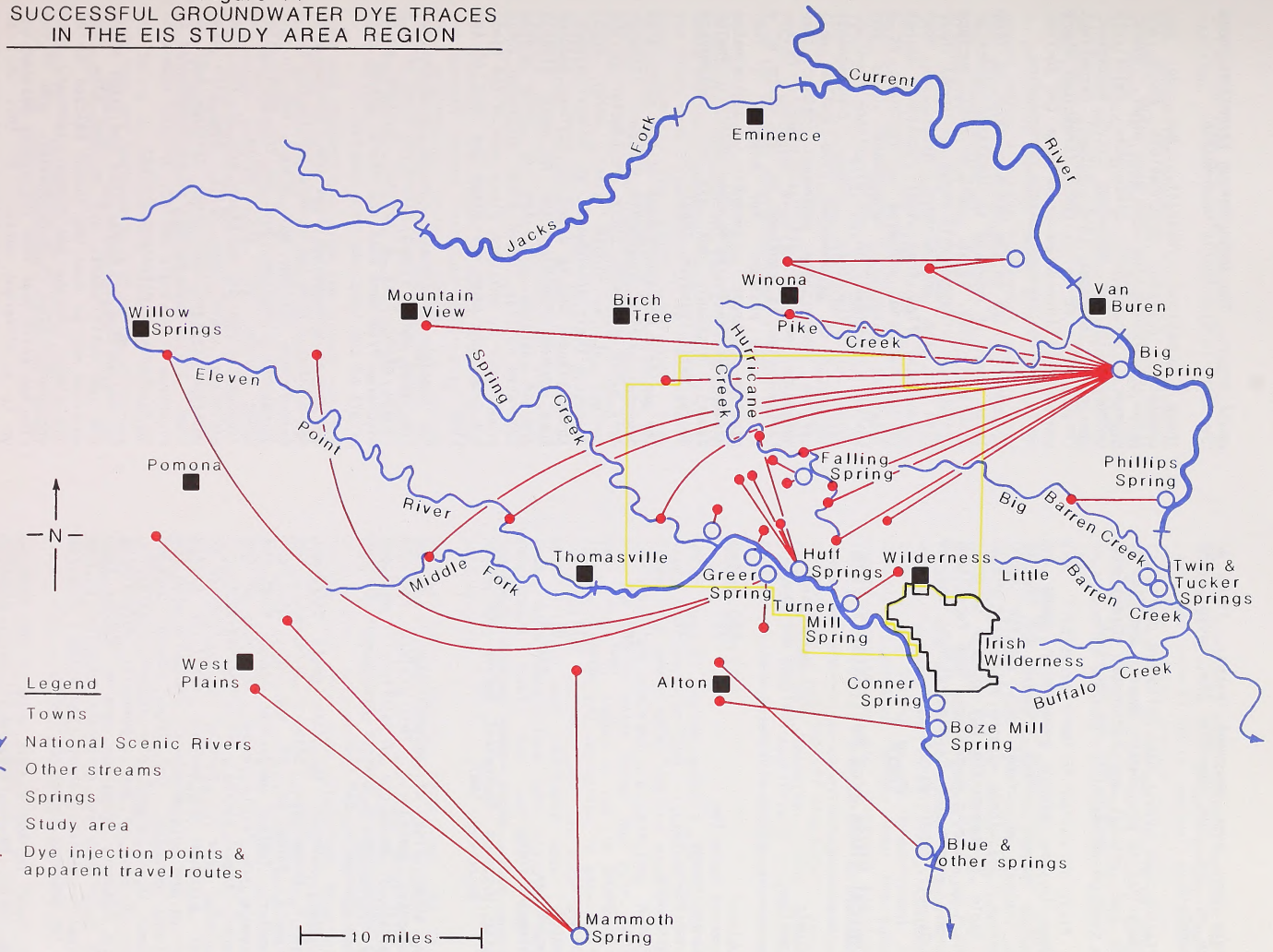
At the other extreme is rapid, turbulent flow through open bedrock fractures, bedding planes and caverns. Travel rates up to several hundred feet per hour have been measured repeatedly over distances up to forty miles where tracers were injected directly into sinkhole bottoms and channel-bottom flow-loss points (Aley, 1975; Vandike, 1982). Lycopodium spores with an average diameter of 33 microns travel into and through the groundwater system just as easily as dissolved chemical dyes like fluorescein (Aley, 1975; USDA-Forest Service).

Underground, diffuse-seepage water may or may not become rapid flow through open passageways. Rapid flow through open passageways, however, does not become diffuse seepage water.

Groundwater extends uninterrupted from near the earth's surface to well below the 2000 foot depths likely to be reached by mining. It does not, however, circulate freely throughout the entire zone.

The average depth below the surface to groundwater level is not static over time. During periods of excessive precipitation, the top of the saturated zone rises above the ground surface causing dry streams to flow. In the absence of continued precipitation, however, the saturated zone retreats back below the surface and these surface streams cease flowing in a few days. Depths to the saturated zone of 35 feet below the channel bottom have been measured near the midportion of the Hurricane Creek valley (Aley, 1975). Even greater fluctuations may occur elsewhere, especially under the higher-elevation areas. Thirty miles to the northeast, groundwater

Figure 14
SUCCESSFUL GROUNDWATER DYE TRACES
IN THE EIS STUDY AREA REGION



levels have been measured (Harvey, 1980) as much as 250 feet beneath the Logan Creek floodplain.

Different rock strata have different degrees of permeability to groundwater seepage and flow in both the vertical and horizontal directions. Two kinds of permeability are important.

The first is called "primary porosity." This refers to how easily groundwater seeps and trickles between bedrock granules and through the tiniest of cracks and similar small openings. The widely varying well-water yields in Table 7 demonstrate how primary porosity differs by geologic formation. Some formations transmit groundwater by slow diffuse seepage fairly well; others do not.

TABLE 7

Typical Study Area Well-Water Yields

Geologic Formation	Well-Water Yield (Gallons per minute)
Roubidoux	25
Gasconade above the Gunter Member	15
Gunter Member of Gasconade	50
Eminence	15
Potosi	500
Derby-Doerun	near 0
Davis	near 0
Bonneterre	20
Lamotte	65
Precambrian basement rocks	near 0

Source: Missouri Geological Survey and Water Resources, 1987.

The other kind of permeability is called "secondary porosity." This refers to the scarcity or abundance of solutionally enlarged and interconnected bedrock passageways through which groundwater can flow.

Secondary porosity is often quite different than a formation's primary porosity. The Eminence Formation is one of the best examples. Typical well-water yields from the Eminence are fairly modest, yet many of the Ozarks' largest springs, including Big Spring, discharge from it. Part of the explanation is that, although the bedrock itself is fairly massive and only moderately permeable with low primary porosity, the large cavern systems common in it signal high secondary porosity. Much or most of the groundwater discharging from Eminence Formation caverns reaches them due to primary and secondary porosity in the Formations above, rather than primary porosity in the Eminence Formation itself.

The least permeable rock unit in the area is the shaley Davis Formation it lies directly above the Bonneterre Formation where mining would occur. The Derby-Doerun Formation above the Davis is also fairly impermeable.

These formations restrict, but do not completely prevent, groundwaters above and below them from mixing with each other. Above, however, groundwater circulates relatively unimpeded in the Jefferson City, Roubidoux, Gasconade, Eminence and Potosi Formations (Figure 12). It is in these formations where contaminants introduced at or near the surface would have the greatest chance of spreading.

Groundwater flow in the Missouri Karst is from large areas of recharge to localized points of discharge (Aley, 1975). Just as small surface tributaries progressively merge to funnel their flow to the mainstream's mouth, so does groundwater flow from widely scattered points in the landscape converge to discharge at a localized point(s). Groundwater does not spread out randomly in all directions from any point of discharge. Thus, contaminants introduced to groundwater also follow well defined subterranean pathways, rather than spreading out in all directions. Often, contamination is confined to the width of a single cave passage. For example, a 1981 pipeline break severely contaminated passageways leading to Maramec Spring in Phelps County, Missouri, but did not contaminate nearby wells (Vandike, 1982).

The geologic characteristics of the study area produces complex groundwater systems. Although many areas discharge their groundwater to the surface at a single place, other areas discharge their groundwater at several places. These places may be areas of diffuse seepage into stream channels, two or more closely grouped springs, or two or more widely separated springs. Many areas discharge their groundwater at only one place some of the time, but from more than one place the rest of the time.

The simplest groundwater systems to understand are those which always discharge from only a single place like a spring. Systems which discharge from more than one place, either part of all of the time, are more complex.

One reason groundwater from one recharge area may discharge from two or more points is that a cave-stream passage may branch out in the downstream direction, just as the Mississippi River does at its delta. If two groundwater-bearing passages are at the same elevation where they split, the flow from upstream divides and flows through both of them. These passages may either reconverge to discharge at a single outlet, or stay separated to discharge at different outlets.

If one passage is higher than the other where the two split apart, all of the flow from upstream may go down the lowest passage during dry times. During wet times, however, when groundwater flow is much greater, some of the flow may spill over into the higher passage and go to a different outlet. In this way, an area's groundwater can discharge at one spring

all of the time and from another spring part of the time.

How common horizontally diverging groundwater passages are in the study area and the Ozarks at large is unknown. Evidence suggests that they exist, but a different underground situation may be more commonly responsible for an area's groundwater discharge from two or more places.

A different, perhaps more common, situation occurs where a single horizontal main passage has several vertical outlets to the surface. The lowest-elevation outlet may discharge groundwater all of the time. If the size of this lowest passage is too small to discharge all of the groundwater flowing toward it, the water will back up and flow out of the next-higher outlet, either part or all of the time. And, if enough groundwater is coming from the area, water may back up behind both of the lowest outlets and discharge from an even higher one yet. Some dye-tracing investigations in the Missouri Ozarks have found groundwater from one point discharging from two springs many miles apart (Figure 14).

It is possible to know conceptually how groundwater behaves in the study area, and where shallow groundwater in different parts of the study area resurfaces. It is impossible to know, however, the exact underground flow routes the water follows from one point to another. Shallow groundwater undoubtedly follows a much more erratic course than is shown in Figure 14. Thus, although it is possible to predict the general direction groundwater contaminants might flow, it is usually impossible to predict with certainty whether or not any particular water-well might be contaminated.

For example, the depth to which precipitation and surface waters circulate vertically into the groundwater system enough to spread significant amounts of surface contaminants is not known with certainty. Nevertheless, reasoned estimates can be made based on various observations.

Cavernous connections from the ground surface to depths as great as 1500 feet are known to occur at West Plains, 30 miles southwest of the study area. Municipal well water there often becomes turbid after rainstorms, even though groundwater from the upper 1000 feet is cased and pressure-grouted out of the wells (Harvey, 1980). Whether this situation is common or rare elsewhere in the Ozarks is unknown, but it does indicate what is possible.

Big Spring on the Current River is recharged from rock and residuum as high as the Jefferson City Formation, and discharges from the Eminence Formation.

Groundwater discharges to the Eleven Point River from the Gasconade Formation which overlies the Eminence.

Blue Spring on the Current River to the northeast of the study area is known to rise to its discharge orifice from a depth greater than 250 feet, and several Ozark springs are known to rise from depths greater than 100 feet. It seems reasonable to assume that large amounts of groundwater circulate quite freely as much as 400 feet below the discharge elevations, and that smaller amounts circulate much deeper than that.

In general, Missouri's experience with pipeline breaks and sewage-lagoon collapses indicates that large slugs of contaminated water introduced directly into the groundwater system through channel-bottom flow-loss points, sinkholes and other ground collapses flush through and out of the system in only a few weeks (Vandike, 1982; Aley, 1975). Contamination of Big Spring by the Midcontinent Iron Company disappeared rapidly when the company ceased operation in 1921 (Vineyard and Feder, 1984). Persistent groundwater contamination seems to depend on a continuous supply of contaminants. Cutting off the supply leads to rapid groundwater cleansing. This behavior suggests that significant groundwater circulation is a relatively shallow phenomenon.

Water Quality

Water quality varies greatly throughout the study area and over time. Locations within the study area where water quality data has been collected and analyzed are contained in Table 8. The Eleven Point River and Huff Springs data shown in Tables 9 and 10 characterize local streamflow and springflow in general. It is important to note that the data are from both filtered and unfiltered water samples. Thus, both particulate and dissolved water constituent levels are included. That is important because some state water quality regulations apply only to dissolved constituents.

Surface water quality throughout the Ozark National Scenic Riverways, the Eleven Point National Scenic River, and their tributaries is excellent. Most of the water is moderately hard to hard, and calcium, magnesium, and bicarbonates originating from the dolomite bedrock are the main dissolved materials. Although surface runoff and floodwaters periodically cause high turbidity, the waters are quite clear most of the time. Water pH is slightly alkaline, generally between pH 7.0 and 8.5. Dissolved oxygen levels are more than adequate for aquatic life, seldom falling below six milligrams per liter (mg/l). The important aquatic vegetation nutrients, nitrogen and phosphorous, occur at low levels typical of uncontaminated Ozark waters. Heavy metals are at low natural levels. Springwater varies from 55-60 degrees F, with maximum streamwater temperatures in the low 80's. (USDA-Forest Service; Duchrow, 1977; Barks, 1978; Bake and Fletcher, 1969; Vineyard and Feder, 1974; Tryon, 1978; U.S. Geological Survey, 1976-85).

None of the surface water can be considered consistently safe for human consumption without antibacterial treatment. In the absence of

TABLE 8
WATER QUALITY DATA LOCATIONS

Station	Location	Agency
1/ Eleven Point River at Thomasville	Highway 99 at Thomasville	F, M
Middle Fork Eleven Point River at Thomasville	Highway 99 South of Thomasville	F, M
Eleven Point River near Thomasville	USGS gage; 2.5 miles east of Thomasville	F, M
Spring Creek near Thomasville	At its mouth, 8 miles ENE of Thomasville	F, M
Eleven Point River near Greer	At the mouth of Long Hollow, 3 miles north of Greer	F, M
McCormack Spring near Greer	4 miles north of Greer	G, F
Eleven Point River near Greer Spring	Just above confluence with Greer Spring	F
Greer Spring	1-1/2 miles north of Greer	G, F, M
Eleven Point River near Greer	At Highway 19	F, M
Huff Springs Group	2 miles NE of Greer	G, F
Falling Spring near Greer	7-1/2 miles NE of Greer	G, F
Hurricane Creek near Greer	County-road bridge above its mouth	F, M
Hurricane Creek near Greer	Forest Service weir near its mouth	F
Turner Mill Spring near Wilderness	4-1/2 miles SW of Wilderness	G, F
Eleven Point River near Bardley	Highway 160 at Riverton	G, F, M
Pike Creek at Van Buren	Highway M	F, M
Big Spring near Van Bureau	3 miles SSE of Van Buren	G, M
Current River near Big Spring	1/2 mile below Big Spring	M
Phillips Spring near Grandin	7 miles west of Grandin	G, F
Big Barren Creek near Bennett	Just above Twin Spring, 4 miles NE of Bennett	F
Twin Springs near Bennett	At mouth of spring branch, 4 miles NE of Bennett	G, F
Tucker Spring near Bennett	4 miles NE of Bennett	G, F

1/ G = U.S. Geological Survey; F = USDA-Forest Service M = Missouri Department of Conservation
Source: USDA-Forest Service, 1987.

surface runoff, however, fecal coliform bacteria levels are well within the accepted limit for safe public swimming.

The excellent water quality is reflected by the consistent abundance of pollution-sensitive macroinvertebrates which dominate aquatic communities (Bake and Fletcher, 1969; Duchrow, 1977).

Local drinking water is drawn from cisterns, wells, and springs. Few wells are deeper than the minimum necessary, and fewer yet are deeply cased and adequately grouted to exclude contaminants. Several Ozark studies outside the study area have found a significant percentage of rural wells to be contaminated (Smith, 1965; Tryon, 1976; Duley, 1983); there is no reason to believe the study area is any different.

Missouri Department of Natural Resources (DNR) regulations (10 CSR 20-7.015) permit the discharge of uncontaminated mine waters, but forbid any type of mill-effluent discharge to the Eleven Point National Scenic River, Ozark National Scenic Riverways, and waters draining thereto. Effluents which enter the aquifers must meet stringent water-quality requirements. The Current and Eleven Point Rivers

TABLE 9
WATER QUALITY SUMMARY FOR THE ELEVEN POINT RIVER AT RIVERTON, MISSOURI

Parameter	Unit	Min	Max	No. of Measurements
Flow	cfs	357	2548	79
Water temperature	degrees F	48	74	83
Turbidity	FTU	0.3	34	78
Apparent color	Pt-Co units	0	50	60
pH	standard units	7.2	8.5	85
Dissolved oxygen	mg/l	4.7	13.9	83
Free carbon dioxide	mg/l	0	73	83
Specific electrical conductance	umhos at 25C	218	398	81
Carbonate alkalinity	mg/l as $CaCO_3$	0	0	71
Bicarbonate alkalinity	mg/l as $CaCO_3$	116	306	21
Total alkalinity	mg/l as $CaCO_3$	128	210	16
Ammonia nitrogen as N	mg/l	0.00	0.30	64
Nitrate plus nitrite as N	mg/l	0.15	0.87	53
Total nitrogen as N	mg/l	0.07	1.38	64
Ortho-phosphate	mg/l	0.00	0.09	54
Total phosphorus	mg/l	0.01	0.28	65
Sodium	mg/l	1.00	1.80	9
Potassium	mg/l	0.80	1.04	12
Chloride	mg/l	0	3	61
Sulfate	mg/l	0	18	63
Calcium	mg/l	20	41	59
Magnesium	mg/l	14	28	59
Copper	ug/l	2	40	16
Iron	ug/l	0	1440	65
Lead	ug/l	Less than 5	60	14
Manganese	ug/l	1	180	16
Zinc	ug/l	Less than 10	260	16
Aluminum	ug/l	50	1100	15
Methylene-blue active substances	ug/l	Less than 10	Less than 50	9
Fecal coliform	no./100 ml	Less than 1	1,450	79

Source: USDA-Forest Service, 1978.

TABLE 10
WATER QUALITY (UNFILTERED SAMPLES) IN HUFF SPRINGS

Parameter	Unit	Min	Max
Flow	cfs	15.6	25.9
Water temperature	degrees F	58	59
Turbidity	FTU	1.1	7.0
Apparent color	Pt-Co units	9	9
pH	standard units	7.5	7.7
Specific conductance	umhos at 25C	258	401
Fecal coliform	no./100 ml	26	26
Dissolved oxygen	mg/l	3.2	8.5
Free carbon dioxide	mg/l	6	13
Carbonate alkalinity as $CaCO_3$	mg/l	0	0
Total alkalinity as $CaCO_3$	mg/l	147	192
Ammonia nitrogen as N	mg/l	less than 0.05	0.05
Nitrate plus nitrite as N	mg/l	0.34	1.31
Total nitrogen as N	mg/l	0.87	1.31
Ortho-phosphate as PO_4	mg/l	0.013	0.027
Total phosphorus as PO_4	mg/l	0.031	0.060
Chloride	mg/l	1.6	2.3
Sulfate	mg/l	0.8	2.3
MBAS	mg/l	0.05	0.05
Total copper	ug/l	10	10
Total iron	ug/l	120	180
Total lead	ug/l	5	25
Total manganese	ug/l	10	20
Total zinc	ug/l	10	70
Total aluminum	ug/l	100	520

Source: USDA-Forest Service, 1977 and 1978.

are designated as Outstanding National Resource Water with any degradation of existing water quality is expressly prohibited (10 CSR 20-7.031).

The Missouri Department of Natural Resources enforces the State's water quality protection program. Both the Forest Service and mining/milling companies must comply with it. Mining/milling effluent-control plans must be approved by the DNR before mining/milling operations can start. If adequate water-quality protection cannot be assured, mining and milling are not permitted.

FLOODPLAINS

Floodplains are defined as areas which are inundated by floodwaters on the average of at least once in one-hundred years. For some special types of floodplain use, the flood-frequency criterion is once in five-hundred years. Executive Order 11988 requires that activities of Federal agencies protect floodplain values to the greatest extent possible, and not increase flood-damage risk more than is necessary.

Floodplain lands occupy about 13% of the area, perhaps a little more because the very smallest areas of alluvial soils were not delineated, and because floodwaters occasionally inundate small areas of non-alluvial soils.

Within the study area, only Carter County participates in the National Flood Insurance Program. Flood-hazard areas have been mapped, and new developments within these hazard areas must comply with the county's floodplain management ordinance. Shannon and Oregon Counties have no such programs.

WETLANDS

Wetlands are areas which support vegetation or aquatic life which depends upon saturated soilsmeadows, river overflows, mud flats and natural ponds. In the study area, poorly drained sinkhole depressions containing hydric soils of the Newark series (Gott, 1975) are also included. Most wetlands located within the study area are less than ten acres in size, many are only an acre or two (Figure 15). Additional wetlands probably exist, but have not yet been identified. Executive Order 11990 requires Federal agencies to. . .

> ". . .provide leadership and. . . take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands ... When Federally-owned wetlands or portions of wetlands are proposed for lease . . . the Federal agency shall (a) reference in the conveyance those uses that are restricted under identified Federal, State or local wetlands regulations; and (b) attach other appropriate restrictions to the uses of properties by the grantee or purchaser and any successor, except where prohibited by law; or (c) with- hold such properties from disposal."

AIR QUALITY

Federal air quality quidelines have established three classes for air quality control for the prevention of significant deterioration of existing conditions. The entire study area is within the Class II category which allows for moderate deterioration associated with limited and managed growth. The Missouri Department of Natural Resources Air Pollution Control Program has primacy for permitting new or modified sources of air pollution. Minerals-related activities which may affect air quality must be approved by the State Air Pollution Control Program. Current State Air Quality Standards for the study area are shown in Table 11.

VISUAL RESOURCES

The study area has diverse terrain throughout. This affords visitors views of some of the most scenic landscape on the Forest. Principle visual corridors are along Highways 19 and J and several Forest Roads, the Eleven Point National Scenic River, the Ozark Trail and Blue Ridge Horse Trail and the Irish Wilderness. The Forest immediately adjacent to these areas and travel routes are the most visually sensitive within the study area.

To protect the visual diversity and sensitivity of the area, objectives have been identified through the Forest Plan (Chapter IV, pp. 31-36). Aesthetic diversity and visually-sensitive travel routes within the study area are shown on Figure 16 and visual quality objectives are shown in Figure 17.

CULTURAL RESOURCES

There are several known prehistoric villages, campsites, lithic scatters and caves within the study area. Known historic sites include farmsteads, churches, cemeteries and single grave sites.

Some inventory and evaluation has been completed within the study area. Forest-wide cultural resource surveys have been conducted on approximately 6% of the Mark Twain National Forest. The site density on the Forest is about one per 100 acres. This correlates with the density within the study area. Sites, however, are not evenly distributed. It is likely there are additional cultural sites within the study area.

The area has been divided into three levels of probability of finding additional sites. Twenty-three percent of the area is at the high

Figure 15: KNOWN WETLANDS IN EIS STUDY AREA

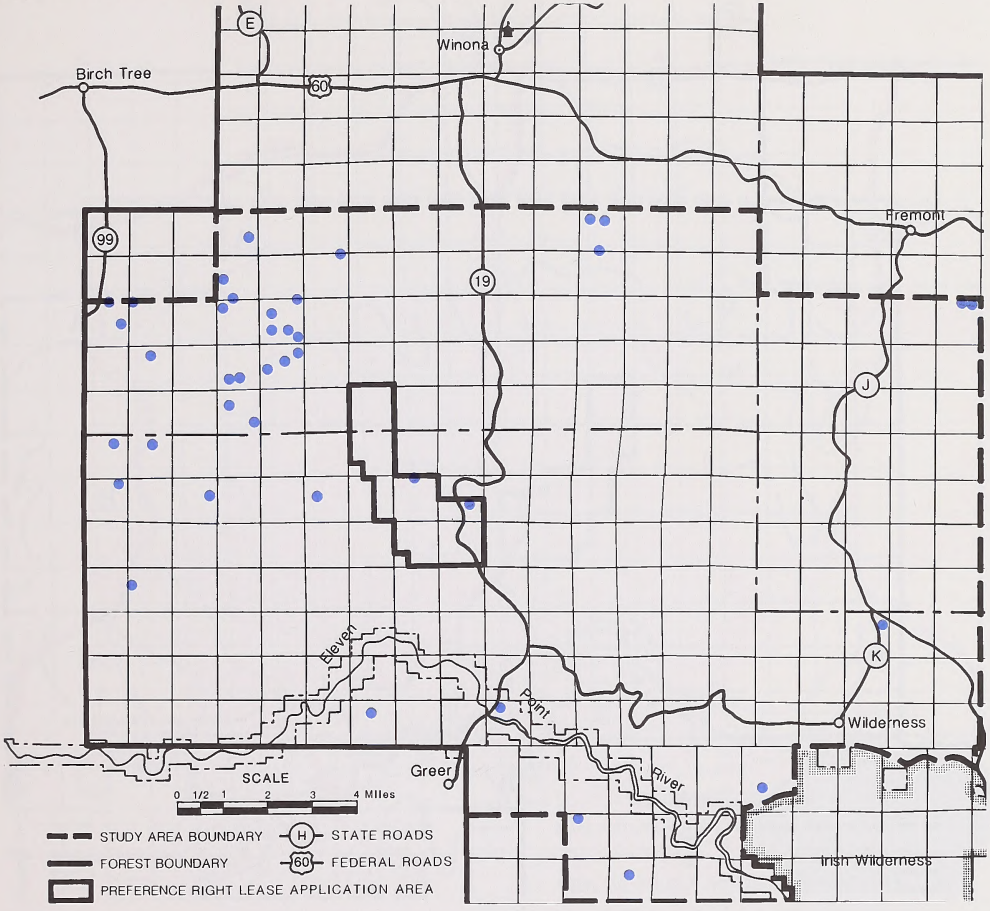
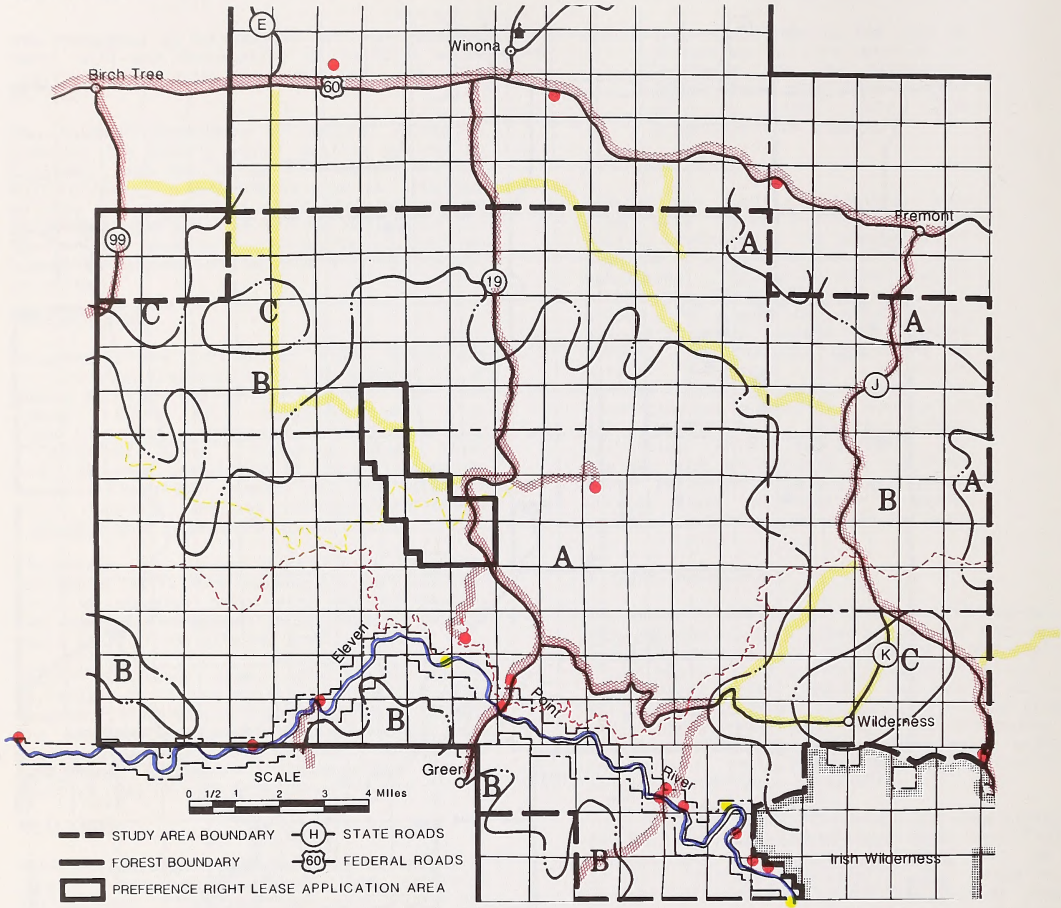


Figure 16: AESTHETIC DIVERSITY AND VISUALLY SENSITIVE TRAVEL ROUTES



LEGEND

Variety Class A - Distinctive (Outstanding quality)

Variety Class B - Common (Typical features)

Variety Class C - Minimal (Minimal variety)

Sensitivity Level 1 - Travel route of users with high visual concern

Sensitivity Level 2 - Travel route of fewer users with visual concern

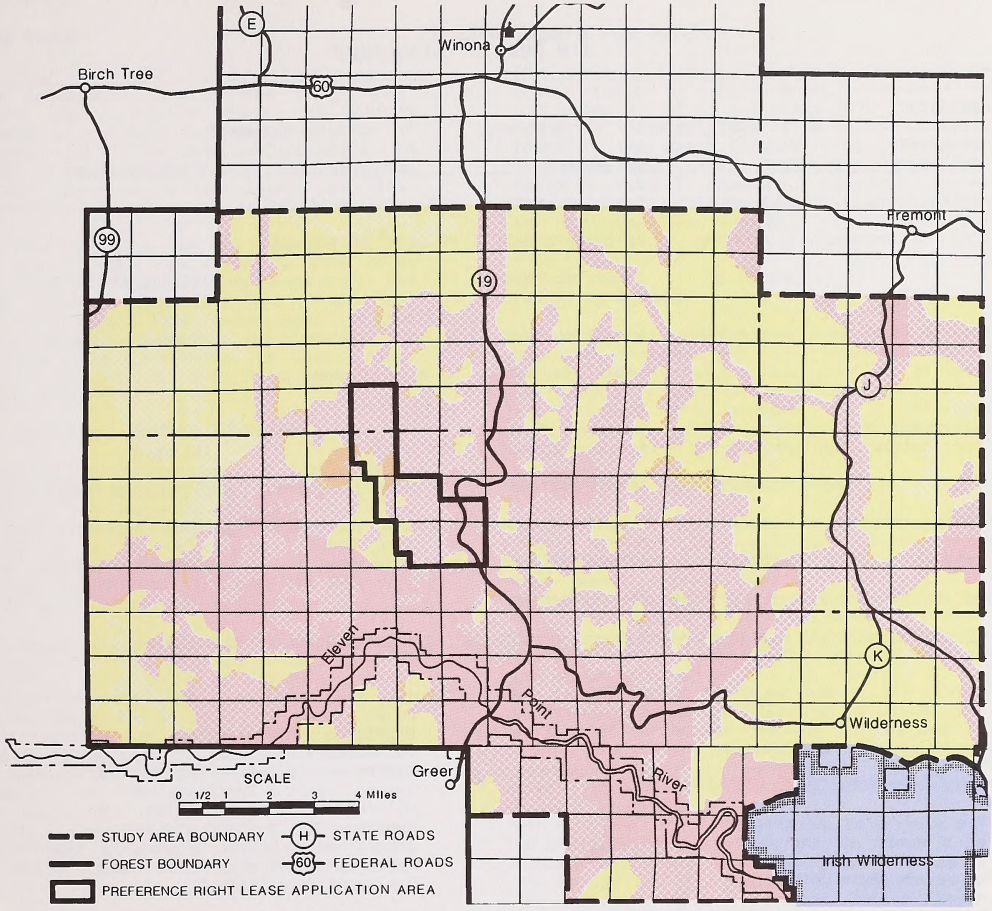
HARDROCK MINERAL LEASING

U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE

MARK TWAIN NATIONAL FOREST-MISSOURI

U.S. DEPARTMENT OF INTERIOR • BUREAU OF LAND MANAGEMENT

Figure 17: VISUAL QUALITY OBJECTIVES (ACCEPTABILITY OF ALTERATIONS)



LEGEND

Retention - R
(Surface disturbance not evident)

Partial Retention- PR
(Surface disturbance evident but visually subordinate)

Modification - M
(Surface disturbance dominant but blends with natural character)

Maximum Modification - MM
(Surface disturbance dominant and departs from natural character)

Preservation

TABLE 11
AIR QUALITY STANDARDS

Primary Standard Pollutant	Averaging Time	Frequency Parameter	Standard Concentration	Secondary Concentration
Sulfur Dioxide	24-hour 1/	Annual Maximum	365 ug/m^3 (0.14 ppm)	
	1 year	Arithmetic Mean	80 ug/m^3 (0.03 ppm)	
	3-hour 1/	Annual Maximum		1300 ug/m^3 (0.5 ppm)
Carbon Monoxide	1-hour 1/	Annual Maximum	40 ug/m^3 (35 ppm)	(Same as primary)
	8 hour 1/	Annual Maximum	10 mg/m (9 ppm)	
Total Suspended Particulate	24-hour	Annual Geometric Mean	75 ug/m^3	
	24-hour 1/	Annual Maximum	260 ug/m^3	150 ug/m^3
Ozone	1-hour 2/	Annual Maximum	235 ug/m^3 (0.12 ppm)	(Same as primary)
Nitrogen Dioxide	1-year	Arithmetic Mean	100 ug/m^3 (0.05 ppm)	(Same as primary)
Lead	3-month	Arithmetic Mean	1.5 ug/m^3	(Same as primary)

1/ Not to be exceeded more than once per year

2/ Not expected to exceed standard more than once per year based on a 3-year average.
Source: Missouri Air Pollution Control Program Report, 1984.

level, 19% at the medium level and 58% at the low level. In general, the highest likelihood of encountering cultural properties is on flat ground near permanent water.

AREAS OF NATIONAL SIGNIFICANCE

The study area embraces or is in the vicinity of a number of nationally designated areas or sites of unique character. These are managed to retain their unique qualities.

These designated areas consist of the Eleven Point National Scenic River, Irish Wilderness and Excluded Lands, Greer Spring, Cupola Pond National Natural Landmark and Ozark National Scenic Riverways.

Eleven Point National Scenic River

The Eleven Point River flows through the southern portion of the area. The 19 mile river segment located in the study area is included within the Eleven Point National Scenic River as designated by the Wild and Scenic Rivers Act. The river is characterized by clear, free-flowing water of high quality, major springs, varied vegetation, cliffs and rock outcroppings, natural setting and opportunities for recreation. The primary uses of the Eleven Point River are boating, fishing, canoeing and camping.

Irish Wilderness

The Irish is one of seven designated wildernesses in Missouri. It borders the study area to the southeast for approximately seven miles. The Irish is 16,500 acres of ozark highlands characterized by rolling hills of oak-hickory forests. The area also has sinkholes, disappearing streams segments and several caves. There are some roads within the wilderness. However, they are closed to the public. The Irish's primary use is dispersed recreation by those seeking to experience the "natural" character of the Ozarks and "wilderness solitude."

Irish Wilderness Excluded Lands

This is a 1,040 acre parcel adjoining the Irish Wilderness to the northwest. This area is referred to as the excluded lands because Congress directed that it be managed as wilderness except that the area is available for mineral development and production.

Greer Spring

Greer is the second largest spring in Missouri, with an average flow of 219 million gallons per day. The Spring is located outside the study area, however it is recharged by water within the area. Greer Spring provides half the Eleven Point Rivers average flow and up to 90% of its low flow. The spring has two outlets located 1-1/4 miles from the river. Greer Spring is significant as an example of the area's complex hydrologic system, a major source of high quality water and the location of several ecological communities.

Cupola Pond

Cupola Pond is a small, water-filled sinkhole located immediately east of the study area. Sinkholes are depressions formed by surface subsidence or collapse due to dissolution of underlying rock. The pond surface varies in size from 5 acres in the spring when full, to less than one acre in late summer and fall. The sinkhole is approximately 30 feet deep.

Cupola Pond is unique for two reasons. First, it is one of very few sinkholes that holds water. Second, the vegetation surrounding the pond is notable. Cupola is one of only two sites where tupelo gum trees grow in the Missouri Ozarks. There are approximately 500 tupelo gum trees surrounding the pond. Also, the pond supports a rare Missouri orchid, Habenaria Cilaris.

Ozark National Scenic Riverways

The Riverways is located about 8 1/2 miles to the northeast of the study area. It is included in this analysis because part of the study area is in the Riverways watershed. The Riverways is a 134 mile long, 86,000 acre national park. It is comprised of Jacks Fork and the Current Rivers. In 1985, the Riverways received nearly 2 million visits.

The Riverways is renowned for its large, clear, cold springs. The largest is Big Spring, located four miles south of Van Buren. Other springs include Welch Spring and Blue Spring on the Current and Alley Spring on Jacks Fork. There are numerous other smaller springs scattered throughout the Riverways. Many of these are fed by waters originating in the study area.

There are also more than 270 caves scattered through the Riverways. Some are quite extensive and magnificantly decorated with dripstone. Others are small and plain.

The Riverways supports a variety of plants, wildlife and fish. There are over 1,500 different kinds of plants and perhaps as many as 200 different kinds of birds within the Riverways. The rivers support more than 112 different kinds of fish.

SPECIAL AREAS

Special areas have unique geologic or biologic features which may be affected by mineral activities. The majority of these special areas are characteristic of karst terrain. Over 30 caves and numerous springs occur within the study area. Several of the larger springs flow from cave mouths. Because caves and springs typically develop in dolomite formations, the majority of such features occur along the Eleven Point River and Hurricane Creek drainages where the dolomite is exposed. Greer Spring is discussed in areas of national significance.

Tupelo Gum Pond

This pond is a natural sinkhole surrounded by gentle ridges of oak-hickory. The pond is surrounded by tupelo gum trees, six to sixteen inches in diameter. This tree is not normally found in the Ozark uplands. The only other site with tupelo trees is in the Cupola Pond National Natural Landmark, discussed above. The pond is covered by pond lily and bordered by cattails and sedges. Four rare and endangered plant species are present at this site (Appendix 5).

Falling Spring

This spring issues from a small cave in the Gasconade Formation and falls about 25 feet to a pond. The spring has been used for at least 100 years as a water and power source for early settlers and more recently, as a site for weddings and picnics. There have been two mills and several other buildings at this site.

Turner Mill Spring and Cave

This area is located within the the Eleven Point National Scenic River. Turner Mill Spring was first used in the 1890's as a water and power source for the community of Surprise. The 26 foot high mill wheel is one of the few remaining indications of this town. The area contains two significant animal species; one on the Federal endangered list and one on the Missouri watch list (Appendix 10).

Horseshoe Bend Bluff

This bluff along the Eleven Point River has been proposed by the public for State Natural Area status. One endangered plant species is present (Appendix 4).

Bliss Spring

The spring is located within the boundaries of the Eleven Point National Scenic River. Although this area has been proposed for State Natural Area status, it has not been evaluated.

LAND OWNERSHIP

The study area encompasses 157,342 acres. Approximately 76 percent (119,421 acres) is in Federal ownership administered by the Forest Service. The remaining land is private, county or State owned (Figure 2). Most of the private lands are isolated, consisting of small tracts concentrated in the northern part of the study area.

RECREATION

The study area provides a variety of recreation opportunities. Water related recreation includes fishing, swimming and floating on the Eleven Point River or the Ozark Riverways. There is hiking along the Blue Ridge or Ozark Trails. The area also include numerous caves used for spelunking. A great deal of the use is dispersed or undeveloped recreation such as trapping, hunting or just walking in the woods.

Developed recreation facilities include the McCormack Lake picnic area and campground; Greer Crossing picnic, campground and river access and the Falling Spring mill picnic area located on Hurricane Creek.

Tens of thousands of people annually visit the Eleven Point National Scenic River and the Ozark National Scenic Riverways. These people come to swim, fish or float on the river and camp, picnic, hike or horseback ride beside the river. These rivers are popular because of the natural setting, high quality water, abundant springs and diverse vegetation and wildlife.

The Blue Ridge Horse Trail is located in the southwest of the study area. It is approximately 14 miles long. Although the trail was developed for horseback riding, it is also used for hiking. Approximately 20 miles of the Ozark Trail have been completed within the study area. When complete, it will run from St. Louis to the Ozark Highlands in Arkansas.

Other popular forms of recreation include hunting and trapping. Deer, turkey and squirrel are the primary targets. Other game species include rabbit, raccoon, coyote, woodchuck, quail, dove and duck. Species trapped include raccoon, mink, beaver, muskrat and opossum.

BIOLOGICAL ENVIRONMENT

VEGETATION

Trees are the dominant vegetation throughout the study area on both public and private land. Black, white and scarlet oak; hickory; and shortleaf pine predominate. Eighteen percent of National Forest System lands within the area contain a mixture of oak and shortleaf pine while 9% is pure pine. About 2% of the National Forest System land is nonforested.

Other hardwoods scattered throughout the area include hackberry, post and blackjack oak, black walnut, ash, blackgum and Eastern red cedar. Smaller trees such as persimmon, flowering dogwood and sassafras are present and stand out in spring or fall because of their floral display or fruits. Scientific names for all species may be found in Appendix 4.

Bottomland hardwoods and riparian vegetation are present along streams and spring branches. Sycamore, river birch, red maple, hackberry, cottonwood and boxelder are some of the typical bottomland species. These areas have higher species diversity and are generally much more productive than other sites.

Understory vegetation in the form of grasses, forbs,shrubs and vines is typical of that found in most of the Ozarks. Species of grasses commonly found include panic grasses, little bluestem, sedges and poverty oatgrass. A variety of forbs is present including tick trefoil, lespedeza, asters, dittany, pussytoes and sunflowers. Greenbrier and wild grape are common, as well as blueberry and poison ivy. Giant cane is present along the Eleven Point National Scenic River. Comprehensive species lists can be found in works by Julian Steyermark, (1963.) The potential for future plant discoveries exists.

Glade habitat species make up a small part of the area's vegetative community. Glades in this area are usually have a south or west aspect with shallow, droughty soils. Glade plants are those typical of prairie communities, including big and little bluestem, indiangrass, sideoats, grama, Missouri evening primrose, coneflowers and blazing star. Glade areas are sensitive to disturbance.

Other openings in the forest canopy are generally man-made. Early farming activity along the creeks and streams resulted in a pattern of small pasture openings adjacent to stream channels. Some of those lands acquired by the Forest Service have been maintained to provide forage and plant diversity for wildlife species. On private land, the emphasis on pasture has resulted in the creation of larger areas of open land along broad ridges. The major forage grass is fescue. Abandoned fields eventually revert to wooded condition though the invasion of oak, hickory, pine, cedar and various other small species such as sassafras and persimmon. Sumac, blackberry, ragweed and goldenrod are common in recently abandoned fields on private land and in openings maintained by the Forest Service. Some old fields on National Forest System lands have been converted to native prairie grasses to provide additional wildlife habitat.

National Forest System land in the study area is managed for timber products in a multiple-use system. Timber productivity is typical of eastern Ozark sites with eighty-two percent of the study area producing from 36-70 cubic feet of wood per acre per year. The age of individual timber stands ranges from one year to over 90 years. The majority of the stands (sixty-four percent) range from 30 to 70 years of age.

Most hardwood sawtimber sold from the study area is used to make pallets, a disposable wooden platform used in shipment and transportation of goods. Other products sawn from hardwood include railroad ties, grade lumber, construction lumber, hardwood flooring and furniture. White oak is used occasionally for whiskey barrel staves. Slabs not used for other products are often burned to manufacture charcoal.

Most softwood sawtimber is used for construction lumber, although some is with a small amount used for other miscellaneous products such as pressboard. There is a fluctuating market for pine posts which are treated and used as fence posts. A small amount of cedar is sold for use as fence posts and in novelty items.

A major factor affecting current timber management decisions in this area is severe mortality of scarlet oak. The publication Forest Seminar on Oak Mortality, May 1983, provides a good overview of the situation. Since 1980, most of the timber sold from National Forest System lands in the study area has been dead and dying scarlet and black oak. One area of scarlet oak has been set aside for as a study of natural successional changes due to mortality.

Plants Species of Special Concern

Thirteen plant species of special concern are known to occur in the study area. There consist of two Federal candidates for listing, seven Missouri endangered, three Missouri rare and one species on the Missouri watchlist. Appendix 5 lists rare, endangered and sensitive plant species in and adjacent to the study area.

In or adjacent to the Ozark National Scenic Riverways. There are 18 listed species occurring which could be affected by a change in water quality or quantity: three Federal candidates for listing, seven Missouri endangered, five Missouri rare and three species on the Missouri watchlist.

There are several reasons for the large number of species listed. Missouri lies at the point where the eastern hardwood types meet western prairie and southern pine types and many of the associated species overlap at the edges of their ranges. This section of the Ozarks also contains many micro-habitats where combinations of climate, moisture, soil, and chemical composition are unique and support species which have adapted to those very specific conditions. If these unique habitats are altered or destroyed, the species dependent on them may be endangered. Some of these habitats with their associated species have never been abundant.

WILDLIFE

Terrestial

The Ozark wildlife community is unusually diverse because of the combination of different environmental conditions represented. Several converging ranges of plant associations meet in the Ozarks. Here, eastern hardwoods, western prairies and southern pine all reach the outer limits of their advance. Because of the variety of vegetation types and successional stages present, there is a diversity of habitats for the 333 vertebrate species found in the study area: 23 amphibians, 34 reptiles, 51 mammals, 59 fish, and 166 birds (refer to Appendix 6 for listing). Scientific names for all species mentioned are found in Appendix 7.

Vegetation information is gathered annually on a certain percent of National Forest System lands. This information is used to describe existing habitats. Table 12 displays current wildlife habitat conditions for 86% of the study area. Conditions on the remaining 14% were not included because current information was unavailable, or because of differences between data collection units and the study area boundary.

TABLE 12
EXISTING WILDLIFE HABITAT CONDITIONS

WILDLIFE HABITAT TYPES	Acreage	%
Ponds and Impoundments	321	(21)
Open and Semi-open Areas	2441	(2)
Regeneration Areas	14161	(14)
Poletimber	39548	(35)
Mature Oak-Hickory	32040	(31)
Mature Pine and Oak-Pine	9856	(10)
Oak Hickory Old Growth	2432	(2)
Pine and Oak-Pine Old Growth	483	(1)
Riparian	308	(1)
Bottomland Hardwood	145	(1)

Source: USDA-Forest Service, 1987.

Forest Plan objectives for wildlife management are to maintain viable populations of all existing native and desired non-native vertebrates, to respond to demand for both consumptive and non-consumptive uses, and to provide for species which require specialized habitats.

Missouri wildlife regulations apply to all National Forest System lands in the study area. Terrestrial game species include woodchuck, bobcat, white-tailed deer, turkey, bobwhite quail, eastern cottontail rabbit, mourning dove, common snipe, American woodcock, fox and gray squirrel, bullfrogs and green frogs, and the common crow. Habitat needs for these species range from permanent water (frogs) to mature hardwood forest (squirrels); from open or brushy areas (deer, bobcat, woodchuck, quail, rabbit, dove) to moist densely forested areas (snipe, woodcock), to a mosaic of forested/open areas with all successional stages represented (deer, turkey). Open or brushy areas on National Forest System lands are limited, but are fairly common on private lands. Moist bottomland forests are found only along the Eleven Point River and a few permanent streams running through the study area. Most of the study area is heavily forested with some limited land available.

Species classed as furbearers include raccoon, beaver, mink, muskrat, river otter, bobcat, coyote, red and gray fox, spotted and striped skunk, opossum, badger and longtailed weasel. Beaver, mink, otter and muskrat require rivers, streams or fair-sized impoundments of water, such as the Eleven Point River and various smaller streams in the study area. Gray fox and bobcats prefer large areas of forested cover broken with small openings or regeneration areas. This habitat type is available in large amounts in the study area. The remaining furbearers can adapt to a variety of conditions, including close contact with man. Most furbearers are opportunistic predators or scavengers, eating anything which

is readily available. Beaver and muskrat are vegetarians, preferring soft bark and aquatic plants.

Various species of small mammals occur in a variety of habitats. Old growth, a small percentage of the study area, is preferred by flying squirrels. These mammals require a variety of foods including worms (eastern mole), seeds, berries, grasses and other plant material (7 mice, 2 rats, 2 voles), acorns (southern flying squirrel and eastern chipmunk) and mice and other small vertebrates (2 shrews).

Raptors include hawks, falcons, owls, eagles, osprey, and vultures. All raptors are predators whose preferred food can be fish (osprey, eagles), carrion (bald eagle, vultures), small mammals (kestrel, screech, barred, great horned and saw-whet owls; and broad-winged, rough-legged, red-tailed and red-shouldered hawks), or small birds (Cooper's and sharp-shinned hawks). Habitat requirements include open areas for red-tailed hawk and kestrel, mostly found on private land; moist woodlands along streams and rivers (red-shouldered hawk), mature oak-pine or pine woods (Cooper's and sharp-shinned hawks) or large expanses of water such as the Eleven Point River (eagles and osprey). Three raptors, the golden eagle, northern harrier and the rough-legged hawk, are winter residents only.

Bald eagles are currently winter residents along the Eleven Point River. Attempts are being made to encourage nesting of eagles in southeast Missouri at Mingo National Wildlife Refuge. Broad-winged hawks, Swainson's hawks and saw-whet owls are summer residents. All other raptors are considered permanent residents. All raptors are predators whose preferred food can be fish (osprey, eagles), carrions (bald eagle, vultures), small mammals (kestrel; screech, barred-great horned and saw-whet owls; and broad-winged, rough-legged, red-tailed and red-shouldered hawks), or small birds (Cooper's and sharp-shinned hawks).

Nine kinds of ducks may be found along the Eleven Point River or at ponds and impoundments throughout the study area. Seven of these are migratory. Only the mallard and wood duck are considered permanent residents. Of five kinds of herons, only the great blue heron is a permanent resident. Three kinds of egrets and the piedbilled grebe migrate through the area in spring and fall. Coots are winter residents.

Small birds comprise one of the largest groups of wildlife in the study area. Virtually every habitat condition has some songbirds associated with it (Evans and Kirkman, 1981). In the study area, approximately 38 kinds are permanent residents, 25 are winter residents, 41 are summer residents, and 14 are migratory, passing through the area in the spring and fall. The seven species of woodpeckers are primary cavity nesters, excavating their own cavities. Eighteen songbird species are secondary cavity users, using natural cavities or ones made and abandoned by primary cavity nesters.

At least 57 species of reptiles and amphibians inhabit the study area. Thirteen are toads and frogs, 10 are salamanders, 19 are snakes, two are lizards, four are skinks, and nine are turtles. Most toads, frogs, and skinks, some turtles, and all salamanders must live close to a water source or in a damp environment. The many temporary pools in streambeds, springs, seeps, small streams, and north and east slopes in the study area provide a fair amount of this habitat. Man-made ponds constructed on National Forest System lands over the last 30 years have greatly improved the availability of this habitat. The snakes occur in a variety of habitats from sluggish water (western cottonmouth) to shrubby upland edges (rough green snake). Some, such as the black rat snake, can live almost anywhere a food source exists. All the snakes are predators, taking bird's eggs, small birds, small mammals, other reptiles or amphibians, or other readily available prey. The lizards, frogs, toads, skinks and salamanders eat mostly insects and other invertebrates. Box turtles are omnivorous and seek out berries and other fruits.

AQUATIC WILDLIFE

The Eleven Point National Scenic River is a high quality Ozark stream with good species diversity. Sixty-two fish species and six fish hybrid combinations have been recorded in the river. Major game species are rainbow trout (mostly stocked), small and largemouth bass, rock bass, grass and chain pickerel, sauger, walleye and various species of sunfish. Carp, suckers, gizzard shad, chub, bullhead and redhorse are all present. American eel, sculpin, and freshwater drum are also river residents. None of the fish species is listed as rare or endangered in Missouri. The fauna is typical of streams in the southern Ozarks of Missouri.

While population information is not complete, it appears that densities of several warmwater fish species are depressed immediately below Greer Spring. Fish growth rates and life span appear to be quite similar to other south-flowing Ozark streams. Several factors make the Eleven Point a unique habitat. Two major types of water conditions are present on the river; warmwater above Greer Spring and cold water below. Greer and other springs keep the river cold enough for rainbow trout from Greer to Riverton, and the State stocks 12,000 trout there annually. One of the last populations of chain pickerel in Missouri exists in the river. This is the highest known density of the species in the State. Other individuals have been found in the Current and St. Francois Rivers, but populations are low at best. The spotted sunfish is at the northwest edge of its range in the river. The Eleven Point population is the farthest west in the State.

The crayfish fauna of the Eleven Point is quite diverse, including six species. All but one are native to the Ozarks. Cambarus hubrichti is a blind, white species restricted to subterranean waters and is State-listed "status

undetermined". Orconectes eupunctus has a very limited distribution, occurring only in the Eleven Point and adjacent Spring River drainages. It is very abundant in the Eleven Point River, which may support the largest population anywhere. Because of its localized distribution, it is State-listed "status undetermined."

Fifteen species of mussels are known from 11 sample sites along the river. None are listed as rare or endangered. Cold water from Greer Spring appears to have an adverse effect on the mussel fauna for at least 16 miles downstream from the mouth of Greer Spring Branch. Frederick Creek, a tributary of the Eleven Point is home for eleven documented species of mussels. Toxolasma lividus glans is listed as endangered in Missouri and has been documented as occurring in Frederick Creek. Information regarding aquatic species of the Eleven Point River has been provided by the Missouri Department of Conservation.

Although it lies outside the study area, the portion of the Current River south of Pike Creek may be impacted by activities within the study area which affect groundwater. Therefore, a discussion of the existing environment is necessary.

One hundred twelve species of fish have been recorded from the Current River watershed. This is one of the most diverse fish faunas for Missouri drainages, and is a result of the presence of characteristic uplands, lowlands, and large rivers together with a large number of species restricted to the Current River watershed.

Upland species make up the bulk of the fauna and occur throughout the river. Most abundant are minnows, suckers, sunfishes, and the small, colorful perches called darters. A few common and characteristic upland species are the streamline chub, bleeding shiner, Ozark minnow, northern hog sucker, black redhorse, smallmouth bass, longear sunfish, rock bass, and rainbow darter. Six species are native to the Ozark uplands of southern Missouri and northern Arkansas: bleeding, wedgespot, and Ozark shiner; checkered and Ozark madtom; and Arkansas saddled darter. The Current River saddled darter and the Current River orangethroat are subspecies found only in the Current River.

Several lowland species penetrate upstream from the Missouri-Arkansas State line for considerable distances. Examples include the ribbon shiner, blacktail shiner, pirate perch, warmouth, and spotted sunfish.

The large, well-sustained flow of the Current River, resulting from numerous springs, provides conditions suitable for fish normally confined to streams of much larger size. The paddlefish, shovelnose sturgeon, skipjack herring, and blue sucker are big river fishes that have been reported from the Current River. The blue sucker has been proposed for Federal listing.

Populations of seven fish species are widely separate from the remainder of the species range. These Ozark populations provide an opportunity to trace changes in fish distribution during and subsequent to the Pleistocene ice advances. Current River fishes showing this type of distribution are the least brook lamprey, streamline chub, popeye and whitetail shiners, southern cavefish, and barred fantail darter.

Twenty years of almost continuous study of the composition and dynamics of Current River fish by the Missouri Department of Conservation has provided valuable information on fish populations. In general, the diversity of the fish communities increases progressing downstream due to the integration of upland, lowland and large river species.

The crayfish fauna of the Current River includes five species. Two species are especially numerous and provide an important food source for fishes and other riverine vertebrates. Studies have shown an annual average standing crop of 9.1 crayfish per square meter of river bottom and that both smallmouth and rock bass obtain over half their annual caloric intake from eating crayfish.
Small plants which float suspended or weakly swim through water are known as phytoplankton. The phytoplankton of Current River is composed almost entirely of minute unicellular or colonial algae known as diatoms. Dominant genera include Cymbella spp., Navicull spp., Nitzchia spp., and Cocconeis spp.

Periphyton are small organisms attached to rocks, gravel, soil, plants, or other surfaces. This community is the most important source of basic food production in the stream ecosystem and is dominated by diatoms such as Cymbella, Achnanthes, Navicula and Gomphonema. Others include the blue-green algae Lyngbya and the green algae Stigeoclonium. One of the primary factors affecting quality and quantity of this community is water quality.

A total of 154 types of aquatic invertebrates have been recorded in Current River and its tributaries. Predominant types are mayflies, beetles, caddisflies, true flies and snails. Based on the results of several studies over the past two decades, a high degree of population similarity exists throughout the river, although some community variation has been noted at different locations.

In addition to the fishes, there are several aquatic vertebrate species present. At least 12 species of turtles, three kinds of snakes, four salamander species, four frog species and two kinds of mammals live in the Riverways.

Clear springs and subterranean cave waters provide unique habitats in the Riverways and throughout the study area. Many species have adapted to the distinctive conditions and are now restricted to these habitats. The diversity of life is limited by stable temperatures and chemical factors, but numbers

of individuals can be extremely high, as in the case of some invertebrates which can exceed several hundred individuals per square foot of surface area.

Detailed biological data are not available for most individual springs, but general characteristics are thought to be similar. Visually dominant forms of vegetation include water cress, water milfoil, water starwart and waterweed. Typical alga are the green algae Nitella and Chara, the red algae Batrachospernum, and several filamentous green and blue-green algae attached to other aquatic plants and surfaces.

The fauna of spring and subterranean waters is dominated by invertebrates such as flatworms, small crustaceans, snails and certain insect groups. Principal vertebrates are fish and salamanders. Some are found in most subterranean waters while other have very limited distribution.

Information regarding aquatic species of the Current River has been provided by the National Park Service.

Caves

There are at least 31 known caves in the study area. Hydrogeologic studies indicate that inaccessible cavern systems of unknown but potentially vast extent underlie the area. Until uncertainties about the extent and contents of the systems are resolved through further study, it is possible that large portions of these systems could harbor cave life which will remain forever undiscovered. If this is the case, some forms of cave life may be more abundant than is at first apparent.

Information on individual caves is on file at the Winona, Van Buren, and Doniphan Ranger District offices. Caves on the Mark Twain National Forest are classified as closed, restricted, or unrestricted based on a combination of hazards and contents. Management recommendations for each category of cave and for some individual caves are given in An Inventory and Evaluation of Cave Resources of Mark Twain National Forest, Gardner and Gardner, 1982. Cave management guidelines are also part of the Forest Plan standards, pages IV-18 through IV-19 and pages IV-50 through IV-52. In the study area, there is one known cave recommended for "closed" status and at least nine caves recommended for "restricted" status.

Caves are a unique biological system and provide habitat for many species (Aley, 1985). Many microhabitats exist within a single cave and cave life is not uniformly distributed in space or time. Although the cave environment is fairly stable with respect to temperature, extreme fluctuations in water level may occur in some caves due to heavy rains and flooding. Caves may be dry except during flooding, or may have streams running through them year round. It is difficult to gather information on cave populations for many reasons: some caves are difficult to access; cave populations may be small and easy to miss; complete darkness makes study more challenging; populations change through time so study must be carried out at different times of the year; some creatures are so unusual that there is only one or no expert available to properly identify them; and human disturbance may cause changes in normal behavior patterns.

The energy to fuel a cave system must come from outside sources since there is no light and hence no photosynthesis taking place. Two ways energy enters a cave are through organic debris washing in and through the deposition of bat guano. A cave may function under one or both of these systems at different times. In addition, animals, especially bats, which enter the cave and die while still inside provide an important food source.

Most Ozark caves do not receive much washed-in organic matter (Aley, 1985). When a cave is fueled by washed-in debris, reproduction of some species populations is triggered usually late winter or early spring. The young thus emerge at a time when food supplies are more abundant than at any other time of year.
In a cave fueled principally with bat guano, reproduction of most species is timed so the young emerge when the bats are contributing the largest amount of guano - usually in late spring or summer when the bats are feeding the most. Bat guano provides a substrate for fungal growth and also attracts small gnats, crickets, beetles, and spiders. These in turn attract larger predators such as salamanders (Rhodes, 1974). Dead bats, and mites and flies which parasitize the bats, also contribute energy to the system.

Some Ozark caves receive about 80-90% of their energy input from bat guano (Aley, 1985). These caves are more susceptible to disruption than debris-based caves because if the bats desert a cave or populations decline dramatically, guano is no longer available and the entire food chain suffers. Colony roosting bats, such as the endangered gray bat, are most important in providing guano.

Because of the lack of photosynthesis, energy is a scarce commodity in most caves. Tom Aley of the Ozark Underground Laboratory has estimated, using guano-rich Tumbling Creek Cave as an example, that a given amount of above ground surface will provide 200 times the energy of the same amount of cave surface. Caves where guano is not available may need 2,000 times the surface area to provide the same amount of energy as above ground (Aley, 1985). Cave dwellers have adapted to this low-energy environment in ways which maximize their food gathering efficiency.

Cave creatures are commonly placed in one of three categories: troglophiles are species which can complete their entire life cycle either in a cave or on the surface; trogloxenes are cave visitors which usually live in caves at some time in their lives, but must leave the cave to find food; and troglobites are those

creatures which never leave the cave. Some spiders are troglophilles, bats are examples of trogloxenes, some spiders are troglophiles, and the Ozark blind salamander is an example of a troglobite.

Most obligatory cave animals (troglobites) are longer-lived with slower metabolic rates than their surface-dwelling counterparts. Because of these factors, cave creatures do not have to grow quickly to sexual maturity and can delay reproduction until food is abundant. A slow and stable reproductive rate is a common physiological adaptation of cave creatures (Gardner and Gardner, 1982). With a limited supply of energy, cave creatures cannot afford rapid increases in numbers. Most populations of cave animals have substantially lower numbers of individuals than do surface dwellers.

Living in the dark, there is no need for camouflage or sight, and most troglobites have lost all pigmentation and the use of their eyes. Instead, they have highly developed sensory devices which help them sense movements of prey or predator. Aquatic troglobites have also developed elongated body shapes and smooth swimming styles to cause less disturbance and enhance their chances of recognizing the small vibrations caused by their underwater prey (Jackson, 1982). Echo location by bats is perhaps the most widely known of the cave dwellers' adaptations for moving easily through the complete darkness of a cave.

Many animals make use of cave entrances and cave passages for nesting, resting, hunting, and shelter. During the inventory of Mark Twain National Forest caves conducted by Gardner from 1978-1982, evidence of cave use was found for seven mammal species (other than bats), four bat species, turkey vultures, eastern phoebes, timber rattlesnake, box turtle, bullfrog, pickerel frog, grotto salamanders, cave salamanders, and the southern cavefish. Forty-six species of vertebrates were reported in this inventory for Mark Twain National Forest caves. There ware undoubtably more animals which occasionally make use of caves.

The most familiar, yet arguably most misunderstood, member of the cave community is the bat. Eleven species of bats are known or likely to occur in caves in the Eleven Point River watershed (Missouri Fish and Wildlife Information System). Four of these are Federal or State listed. Bats are important predators of night-flying insects, eating the equivalent of 50% or more of their body weight each night (Jackson, 1982). Some bats roost in caves year round, some migrate between caves in different areas, and some use caves only at certain times of the year. Different species of bats have different and very specific temperature and humidity requirements at different times of the year. Most bats hibernate through the winter, rousing only to excrete wastes (Jackson, 1982)

Other inhabitants of caves in the study area may include spiders, crickets, and harvestmen which prefer drier walls and ceilings; cock roaches, beetles, and milliepedes which can be found on decomposing litter; amphipods, isopods, and flatworms on the bottom of cave streams; crayfish and fish in streams; and salamanders throughout wet or humid caves, or in moist areas (Jackson, 1982).

During the 1978-1982 cave inventory, 269 individual invertebrates were collected from every conceivable habitat in caves visited on the Winona District (Appendix 8). Flies, beetles, and spiders were the individuals most commonly encountered. Identification was possible down to species level for 68 species, to family level for seven families, and to order level for nine orders.

Because of the uniqueness of cave habitats and the ease with which they can be disturbed, several species which inhabit caves are Federally or State listed as endangered, threatened, or rare. Information on specific habitat requirements of federally-listed cave species can be found in the Biological Assessment prepared for this project (Appendix 9). Some other species are on the Missouri watchlist or so little information is known about then that their status is undetermined. Jim H. Wilson, Missouri Department of Conservation, Endangered Species Coordinator, reported that during the inventory of Mark Twain National Forest caves, two newly described species of troglobitic invertebrates were discovered in caves in the study area.

Animals of Special Concern

The Forest Plan explicitly states that protection of threatened, endangered, rare, or sensitive species takes priority over other project objectives. Where these species are encountered, projects will be modified as necessary to ensure continued existence of the species as a viable population. Forest Plan Standards outline specific steps for protection of some listed species.

Species requiring special habitats also receive priority where they are encountered. Caves, springs, seeps, fens, glades, bottomland hardwood stands, riparian areas, fishless ponds and shortleaf pine forests are all considered special habitats. Guidelines for protection or management of these habitats are found in the Forest Plan Standards for Species with Specialized Habitats (pp. IV-51 through IV-58).

As shown in Table 13, 21 listed animal species are known to occur in the study area; three Federally endangered, three Missouri endangered, and four Missouri rare. Also present are four species on the Missouri watchlist and six species whose status cannot be determined from the information currently available. There are 16 additional listed species which may occur, but have no locations recorded; one Federally endangered (possibly extirpated), one Federally threatened, four Missouri endangered, and nine Missouri rare. One species whose status is undetermined in Missouri may be present in the study area.

TABLE 13
OCCURRENCE OF LISTED ANIMAL SPECIES AND SPECIES OF CONCERN

	Occurrence	Possible Occurrence	Occurrence in Ozark N.S.R.
Federal Endangered	3	1 1/	4 1/
Federal Threatened	-	1	-
Federal Proposed	-	-	1
Missouri Endangered	3	4	5
Missouri Rare	4	9	9
Missouri Watchlist	4	-	11
Status Undetermined	6	1	3
Concern Species	1	-	1
TOTAL	21	16	34

1/ One species possibly extirpated

FEDERAL ENDANGERED - Species that have been designated as being in danger of extinction throughout all or a significant portion of their ranges.

FEDERAL PROPOSED - Species which have been proposed for official listing; however, information is being analyzed to determine if listing is necessary.

MISSOURI ENDANGERED - Species whose prospects for survival within Missouri are in immediate jeopardy.

MISSOURI RARE - Species present in small numbers in Missouri. If environment worsens, continued presence in State is endangered.

MISSOURI WATCHLIST - Species of possible concern for a variety of reasons. They do not have official status but are listed as additional species for which the Missouri Department of Conservation is seeking information.

MISSOURI STATUS UNDETERMINED - Possible rare or endangered but not enough information is available to determine the proper status.

CONCERN SPECIES - No official status but because it is an indicator of riparian habitat quality and a colony nester, the continued existence of breeding population is monitored.

POSSIBLY EXTIRPATED - Formerly occurred in Missouri, but is not now known to exist in the State.

Source: USDA-Forest Service, 1987.

The 34 listed species occurring in the Ozark National Scenic Riverways could be affected by a change in water quality or quantity: four Federally endangered (one possibly extirpated), one proposed for Federal listing, five Missouri endangered, and nine Missouri rare, eleven on the Missouri watchlist and three whose status is undetermined (Table 13).

There are several reasons for the large number of species listed. Because Missouri lies at the point where eastern hardwoods meet western prairie and southern pine, many of the species are at the edge of their range. These may be abundant in other States, but are not in Missouri. This section of the Ozarks also contains many microhabitats where combinations of climate, moisture, soil, and chemical composition are unique and support species which have adapted to those very specific conditions. If these unique habitats are altered or destroyed, the species dependent on them are also endangered. Some of these habitats with their associated species have never been abundant. Appendix 10 lists the threatened and endangered animals in the study area and in the Ozark National Scenic Riverways.

ECONOMIC ENVIRONMENT

The economic and social impacts of activities on a National Forest typically extend well beyond the specific sites where the activities occur. The economic and social effects of a

new mine would not be limited to the 119,000 acre study area. Industries necessary to support the operation through the provision of material, equipment and services will, in many cases, be located a great distance from the mine. Further processing of the lead, zinc and copper concentrates which are produced will take place outside the immediate area at other locations in Missouri (e.g., Herculaneum) or in other states. The refined metal may ultimately be shipped to markets overseas.

The influence of a new mine on other Forest activities would also extend beyond the study area boundaries. For example, if the demand for recreation shifted as a result of a mining operation, sales of recreation equipment in St. Louis might change. Although the economic and social impacts would clearly be widespread, it is necessary to place a limit on the geographic scope of the analysis.

To determine the boundaries of the area where major effects would likely occur, a number of factors must be considered. The area should be large enough to contain the more populated cities and towns adjacent to the study area which provide most of the goods and services required by the inhabitants. Large cities are not included in the analysis area, since Forest activities are unlikely to affect employment and income very much due to the sheer size of the city. The commuting and residential patterns of workers are other factors that are important in determining the extent of the zone of influence.

Based on such considerations, the analysis area for major economic and social effects of a new mining operation is defined to include the following six counties in Missouri: Butler, Carter, Howell, Oregon, Ripley and Shannon (Figure 18). Although the focus will be on the analysis area as a whole, information will often be presented for the individual counties. In addition, comparisons with State and national trends will be made, where appropriate.

POPULATION

As of July 1, 1985, the population of the analysis area was estimated to be 104,900 (Table 14). The population grew at an average rate of 1.2% per year over the 1970 to 1985 period, which is comparable to the growth rate for the United States, but higher than that for Missouri (Figure 19). The expansion in the analysis area population was quite rapid during the 1970's but the rate of increase slowed considerably from 1980 to 1985. The growth in population varied substantially between counties, with Carter County increasing at the fastest rate and Oregon County the slowest over the 15 years. The population of Oregon County has declined since 1980.

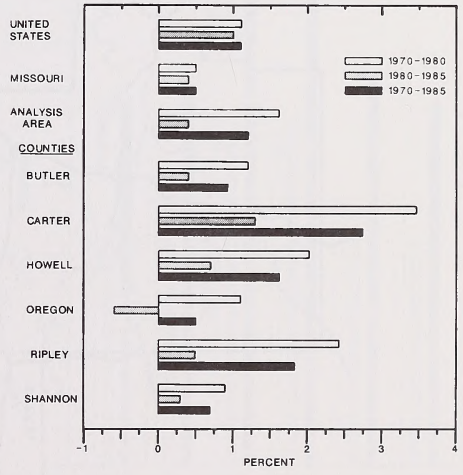
There seems to be little doubt that the trend observed throughout the United States during the 1970's of people moving from urban to rural areas was, at least partially responsible for the rapid population growth of the analysis area in that decade. Individuals and businesses alike moved to rural areas to escape the congestion, crime, high costs, and pollution found in many large cities. Migration has played a role in the population growth in the analysis area and this is evident from the fact that in Carter County, for example, fully 38% of the residents over 5 years of age in 1980 had lived in a different county in 1975. The population characteristics of the analysis area will be discussed in more detail in subsequent sections.

TABLE 14
ANALYSIS AREA POPULATION BY COUNTY

	1970	1980	1985
Analysis Area	87,107	102,509	104,900
Butler	33,529	37,693	38,500
Carter	3,878	5,428	5,800
Howell	23,521	28,807	29,900
Oregon	9,180	10,238	9,900
Ripley	9,803	12,458	12,800
Shannon	7,196	7,885	8,000

Source: Bureau of the Census, 1982 and 1986.

Figure 19
AVERAGE ANNUAL RATE OF CHANGE IN POPULATION



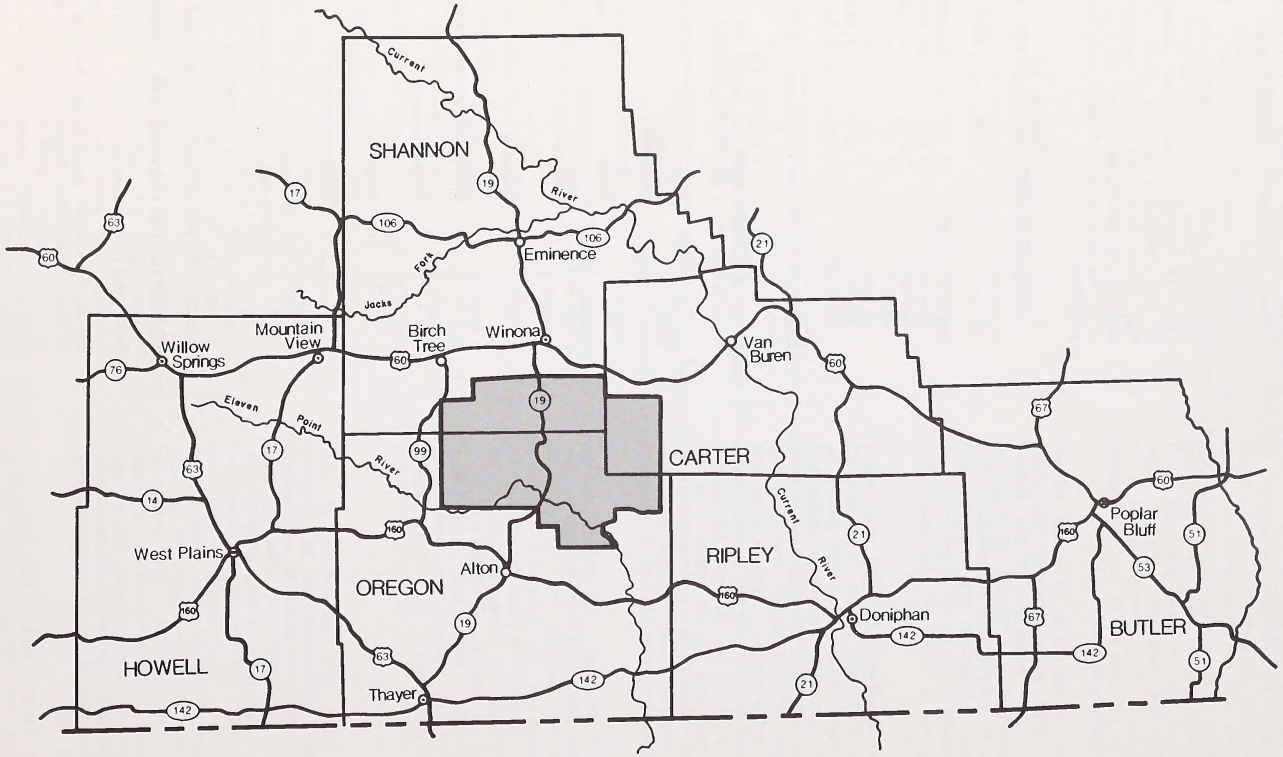
Source: Bureau of Census, 1982 and 1986.

ECONOMIC INDICATORS AND TRENDS

Personal Income

Personal income is defined by the U.S. Department of Commerce, Bureau of Economic Analysis, as the income received by persons from all sources including wages and salaries, other labor income, proprietors' income, transfer payments, dividends, interest and rent. Expressed in real terms (constant 1985 dollars), total personal income in the six-

Figure 18: ECONOMIC AND SOCIAL ANALYSIS AREA



county area amounted to $808 million in 1984, with personal income in the individual counties ranging from $35 million in Carter County to $334 million in Butler County.

Over the 1979 to 1984 period, real personal income increased at an average annual rate of 1.6% in the analysis area compared to 2.5% for the U.S. and 1.8% for Missouri. The much more marked decrease in farm income in Missouri and the analysis area accounts for the slower growth in total personal income relative to the U.S. figure. While real farm income nationally fell at an average rate of 5.9% per year from 1979 to 1984, in Missouri, the rate of decline was 24.5% per year and in the analysis area, the average annual rate of decrease was 22.7%.

In Missouri agriculture, the major emphasis is on corn, wheat, soybeans, cattle, hogs and chickens. Between 1979 and 1984, the demand for corn, wheat, and soybeans was adversely affected by the embargo on exports to the Soviet Union. During this period, people's dietary preferences were also changing which resulted in lower consumption of beef and pork. Because Missouri farms tend to be smaller, less productive, and higher cost than farms in other states producing the same commodities, they are more vulnerable to such reductions in demand and financially less able to survive. Thus, farms in Missouri and the analysis area experienced a much greater proportionate drop in income over those 5 years.

To compare income between areas, a more useful measure than total personal income is the per capita personal income which is total personal income divided by the population. Table 15 presents per capita income for the analysis area, Missouri, and the U.S. for 1979 and 1984. It is clear from Table 15 that per capita income in every county in the analysis area was far below state and national figures. Recognizing that the cost of living in the analysis area is probably less than the state or U.S. average, it is still true that, on a per capita income basis, several counties in the analysis area rank among the lowest in the entire nation. As an example, of all U.S. counties with total personal income of $50 million or higher in 1984, Ripley County was 15th from the bottom. Per capita income in the analysis area in 1984 was only 58% of the U.S. figure of $13,197 and in no county in the analysis area was per capita income even 70% of the national measure. In real terms, per capita income in the analysis area increased at an average rate of 1.2% per year from 1979 to 1984, with individual counties ranging from -0.2% per year (Oregon County) to 2.0% per year (Carter County).

Labor Force

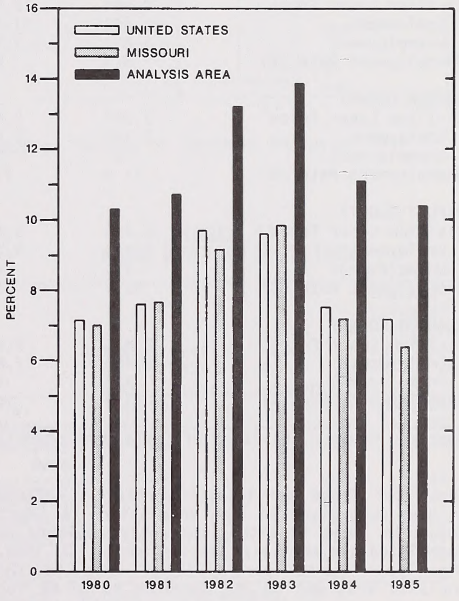
The civilian labor force in the analysis area reached the 43,000 level in 1985 with 38,568 employed and 4,497 unemployed. The unemployment rate for 1985, therefore, 10.4% several percentage points above both the U.S. and Missouri averages (Figure 20). Table 16 presents the labor force statistics for the

TABLE 15
PER CAPITA PERSONAL INCOME
(constant 1985 Dollars)

	1979	1984	Average Annual Percentage Change, 1979-1984
United States	12,294	13,197	1.4
Missouri	11,713	12,477	1.3
Analysis Area	7,261	7,697	1.2
Butler County	8,009	8,707	1.7
Carter County	5,552	6,140	2.0
Howell County	7,658	8,033	1.0
Oregon County	6,853	6,795	-0.2
Ripley County	5,798	6,110	1.1
Shannon County	6,209	6,377	0.5

Source: Bureau of Economic Analysis, 1986.

FIGURE 20
UNEMPLOYMENT RATES, 1980-1985



Source: Missouri Division of Employment Security, Various Years.

analysis area for 1980 to 1985. Although unemployment rates in the six-county area have been higher than the U.S rate, they have generally moved in the same direction as the national figure. Those counties with a larger, more diversified economy have tended to experience lower unemployment rates over the years.

TABLE 16
LABOR FORCE STATISTICS, 1980-1985

	1980	1981	1982	1983	1984	1985
ANALYSIS AREA						
Civilian Labor Force	39,705	40,085	40,218	41,341	42,928	43,065
Employment	35,622	35,807	34,903	35,596	38,197	38,568
Unemployment	4,083	4,278	5,315	5,745	4,751	4,497
Unemployment Rate (%)	10.3	10.7	13.2	13.9	11.1	10.4
BUTLER COUNTY						
Civilian Labor Force	15,501	15,699	15,316	16,288	16,261	16,316
Employment	13,929	13,855	13,235	14,041	14,535	14,744
Unemployment	1,572	1,844	2,081	2,247	1,726	1,572
Unemployment Rate (%)	10.1	11.7	13.6	13.8	10.6	9.6
CARTER COUNTY						
Civilian Labor Force	2,268	2,310	2,594	2,874	2,433	2,375
Employment	1,994	2,086	2,297	2,528	2,116	2,037
Unemployment	274	224	297	346	317	338
Unemployment Rate (%)	12.1	9.7	11.4	12.0	13.0	14.2
HOWELL COUNTY						
Civilian Labor Force	12,494	12,592	12,930	12,603	12,988	12,983
Employment	11,403	11,409	11,415	11,091	11,710	11,738
Unemployment	1,091	1,183	1,515	1,512	1,278	1,245
Unemployment Rate (%)	8.7	9.4	11.7	12.0	9.8	9.6
OREGON COUNTY						
Civilian Labor Force	2,870	2,839	2,919	3,054	3,751	3,752
Employment	2,529	2,526	2,572	2,654	3,329	3,340
Unemployment	341	313	347	400	422	412
Unemployment Rate (%)	11.9	11.0	11.9	13.1	11.3	11.0
RIPLEY COUNTY						
Civilian Labor Force	3,746	3,655	3,514	3,515	3,943	4,310
Employment	3,271	3,243	2,927	2,848	3,510	3,876
Unemployment	475	412	587	667	433	434
Unemployment Rate (%)	12.7	11.3	16.7	19.0	11.0	10.1
SHANNON COUNTY						
Civilian Labor Force	2,826	2,990	2,945	3,007	3,552	3,329
Employment	2,496	2,688	2,457	2,434	2,997	2,833
Unemployment	330	302	488	573	575	496
Unemployment Rate (%)	11.7	10.1	16.6	19.1	16.2	14.9

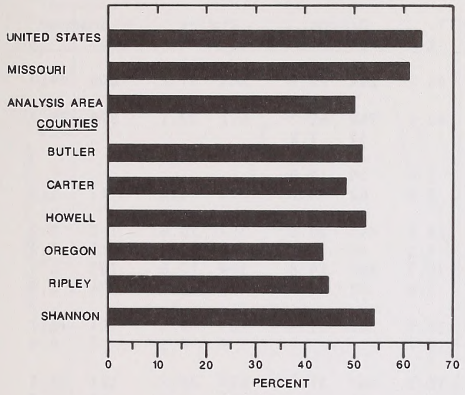
Source: Missouri Division of Employment Security, Various Years.

The labor force participation rate is defined as the percentage of the population 16 years and older that is either currently employed or unemployed and actively seeking work. In 1980, the labor force participation rate in the analysis area was 50.3%, compared to 63.8% for the U.S. and 61.1% for Missouri (Figure 21). Labor force participation rates in the individual counties in the analysis area ranged from 43.4% in Oregon County to 53.8% in Shannon County. It would appear that the lower participation rates in the analysis area could be a reflection of the higher proportion of retirees, as well as jobseekers who eventually become discouraged from the lack of job opportunities and drop out of the labor force.

Economic Base

Figure 22 shows, in terms of earnings, the importance of different industries in the analysis area. Earnings for the mining industry, the transportation, communication and public utilities sector, and the agricultural services, forestry and fisheries industries do not appear in the figure, since the number of firms in those categories in some counties was so small that the earnings information could not be determined (their relative share of total earnings could, however, be approximated from the available data). Compared with the distribution of earnings for the U.S. and Missouri, the analysis area is relatively more reliant on agriculture, retail trade, and the government sector, while mining and manufacturing in the analysis area each account for a smaller percentage of total earnings. Of particular note in Figure 22 is the previously discussed shrinkage in farm earnings in the analysis area over the 1979 to 1984 period. In

FIGURE 21
LABOR FORCE PARTICIPATION RATES, 1980



Source: Bureau of the Census, 1983.

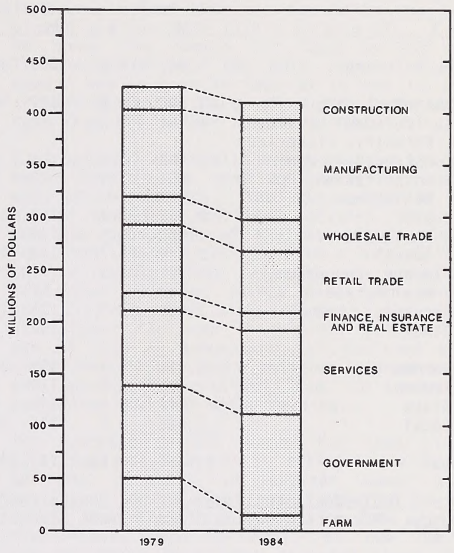
1979, farm earnings made up 11% of the total, but by 1984, the share had fallen to 3%. For the nation, the comparable proportions were 3% in 1979 and 2% in 1984. Table 17 contains relevant information from the 1982 Census of Agriculture.

In the nonagricultural category, even though the manufacturing industry's share of total earnings was lower in the analysis area than in the U.S. and Missouri, the gap had narrowed considerably by 1984. For example, real manufacturing earnings in the analysis area grew at an average annual rate of 2.9% between 1979 and 1984, while, over this same period, real manufacturing earnings in the U.S. and Missouri actually declined. Table 18 provides data regarding nonagricultural employment in the six-county area.

Historically, wood products manufacturing has been extremely important to the economy of the analysis area, and the growth of a number of towns, such as Doniphan, West Plains Eminence, and Winona, can be traced to the establishment of sawmills. Some of the major products manufactured today in the analysis area include dimension lumber, hardwood flooring, charcoal, pallets, poles, stave bolts, wooden handles, furniture, gunstocks, plaques, and trophies.

In addition to wood products, there is a wide variety of other items being manufactured at different locations. In the agricultural-related category, there are meat packing and poultry dressing plants, along with facilities producing breakfast cereals and feed for pets and other animals. A significant number of people are also employed in the production of apparel (e.g., caps, uniforms, jackets, lingerie and shoes), truck bodies and trailers, electric motors, and fiberglass boats.

FIGURE 22
ANALYSIS AREA EARNINGS BY INDUSTRY
(Constant 1985 Dollars)



Source: Bureau of Economic Analysis, 1986.

TABLE 17
FARM STATISTICS, 1982

	Number of Farms	Average Size (acres)	Hired Labor (# of workers)	Market Value of Agricultural Products Sold (average per farm)
U.S.	2,240,976	440	4,855,857	$58,858
Missouri	112,447	260	101,615	32,076
Analysis Area	4,801	245	3,716	23,803
Butler Co	940	288	1,038	46,088
Carter Co	202	268	148	9,043
Howell Co	1,734	206	1,153	20,463
Oregon Co	921	267	424	21,697
Ripley Co	547	244	401	15,998
Shannon Co	457	252	552	10,748

Source: Bureau of the Census, 1984.

The retail trade and service industries which support recreational pursuits are very important to the six counties. The six-county area has long been a popular recreation area for residents and nonresidents alike. Among the favorite activities are fishing, hunting, camping, floating, and picnicking (as an indication of how desirable the area is for recreation, Table 19 shows the 1985 visitor use statistics for the Lower Current River). The affected retail trade industries, includes

TABLE 18
NONAGRICULTURAL WAGE AND SALARY EMPLOYMENT: 1985

	Butler		Carter		Howell		Oregon		Ripley		Shannon	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Manufacturing	1,617	14.0	395	34.9	3,005	33.2	234	15.9	540	31.2	566	44.9
Nonmanufacturing	7,508	64.8	347	30.6	4,568	50.5	768	52.2	677	39.1	374	29.7
Agricultural Services, Forestry, Fisheries	61	0.5					17	1.2				
Construction, Mining	402	3.5	7	0.6	214	2.4	30	2.0				
Transportation, Public Utilities	451	3.9	28	2.5	327	3.6	62	4.2	74	4.3	17	1.3
Trade	3,733	32.2	158	14.0	2,185	24.2	441	30.0	357	20.6	122	9.7
Wholesale	988	8.5	9	0.8	403	4.5	76	5.2	49	2.8	15	1.2
Retail	2,744	23.7	149	13.2	1,782	19.7	365	24.8	308	17.8	107	8.5
Finance, Insurance, Real Estate	425	3.7			267	3.0	52	3.5	76	4.4	36	2.9
Services	2,436	21.0	121	10.7	1,565	17.3	167	11.4	161	9.3	191	15.2
Other			32	2.8	11	0.1			9	0.5	7	0.6
Government	2,461	21.2	390	34.5	1,471	16.3	467	31.8	514	29.7	321	25.5
Federal	625	5.4	110	9.7	125	1.4	85	5.8	67	3.9	84	6.7
State	416	3.6	45	4.0	289	3.2	42	2.9	62	3.6	54	4.3
Local	1,420	12.2	235	20.8	1,057	11.7	340	23.1	385	22.2	183	14.5
Total	11,586	100.00	1,131	100.0	9,044	100.0	1,470	100.0	1,731	100.0	1,260	100.0

Note: Individual totals may not add due to rounding.
Source: Missouri Division of Employment Security, Various Years.

TABLE 19
LOWER CURRENT RIVER
VISITOR USE, 1985

Category	Visitor Days
Canoeists	29,929
Anglers	9,637
Powerboaters	19,059
Innertube Floaters	25,204
Concession Boat Passengers	3,213
Other[1/]	459,156
Total	546,198

1/ Includes picnickers, hikers, and campers.

Source: National Park Service, 1986.

sporting goods stores, gasoline stations, restaurants, and dealers selling boats and campers. Canoe rentals and lodging (e.g., motels, camp-grounds, trailer parks) are prominent recreation-related service industries in the analysis area.

LEAD MARKET

Currently, the largest domestic use of lead is in storage batteries for the startup of vehicles, ships, and aircraft. Uninterruptible power supply (UPS) systems for hospitals, computers, and communications also use lead-acid storage batteries. A growing application of lead is in traction batteries for airport tugs, forklifts, and utility vehicles.

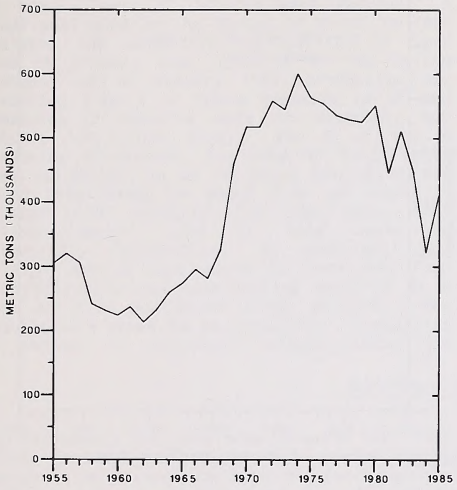
Lead is employed in construction in roofing, flashing, piping and caulking and as a sound barrier and radiation shield. Lead oxides are used in paint to provide corrosion resistance for steel in building and highway structures, and lead is added to gasoline to enhance the octane rating and for antiknock purposes. Other products containing lead include cable sheathing and ammunition (shot and small caliber bullets).

Supply

The U.S. mine production of recoverable lead in 1985 was 414 thousand metric tons (Figure 23), a sizable increase over the 1984 figure of 322 thousand metric tons. Output in 1984, however, was affected by lengthy strikes at most of the primary lead mines in Missouri, so disregarding that year, the 1985 production was the lowest since just before the Viburnum Trend mines were reaching capacity in the late 1960's. Approximately 90% of the lead mined domestically in 1985 came from seven deposits in Missouri. Copper, zinc, cadmium and silver are important byproducts from the primary lead mines.

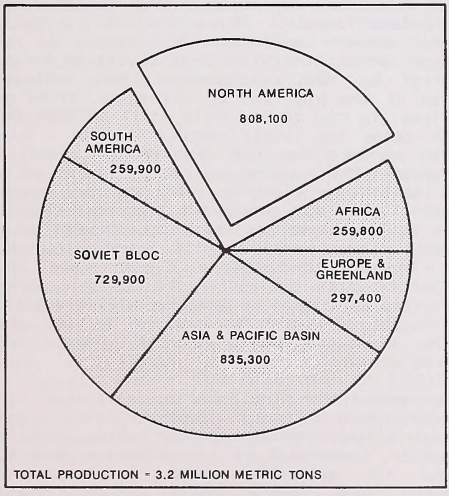
The world mine production of lead totalled 3.4 million tons in 1985 with the U.S. accounting for 12%. Historically, the United States has been one of the world's top producers along with Canada, Mexico, the U.S.S.R., Peru, and Australia. On a regional basis, North America made up 26% of the 1984 world mine production (Figure 24) and the regional shares have been quite constant over at least the last 20 years.

FIGURE 23
U.S. MINE PRODUCTION OF LEAD



Source: Bureau of Mines, Various Years.

FIGURE 24
WORLD MINE PRODUCTION OF LEAD, 1984



Source: Bureau of Mines, 1986.

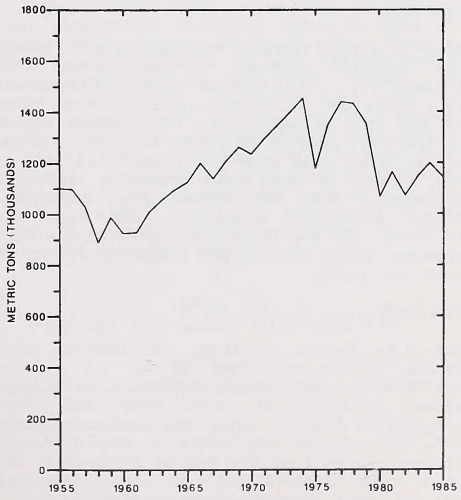
Demand

The reported consumption of lead in the United States was 1.15 million metric tons in 1985, a 5% decrease from 1984 and far below the peaks of the mid and late 1970's (Figure 25). Figure 26 shows the demand for lead by end use. Transportation was the only sector in which demand was as high in 1983 as it was in 1964. Transportation's share of total lead demand rose from 33% in 1964 to 68% in 1983.

Environmental and health concerns have played a major role in the drop in demand for lead in many of the sectors. The consumption of lead as a gasoline additive declined with the mandated production of engines using unleaded fuel and, more recently, with a reduction in the allowable lead content in gasoline. Lead-based interior paints have been banned, and titanium and zinc pigments are being substituted for lead in exterior paints. The use of lead in ammunition has declined after links have been shown between lead poisoning and waterfowl mortality due to waterfowl consuming lead shot while feeding.

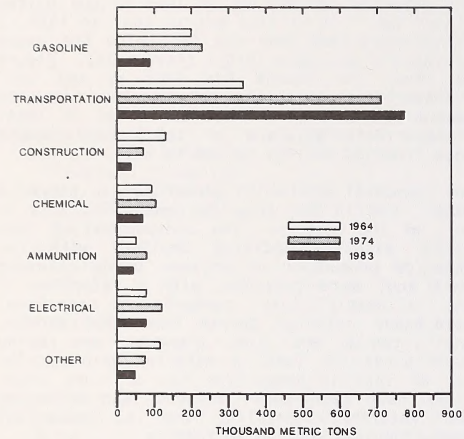
The decrease in the demand for lead in the construction sector can be attributed primarily to the slowdown in nuclear power plant activity. With nuclear power shown to be more costly than electrical generation from alternative fuels, such as coal, no new nuclear reactor units have been proposed since 1978, and plans to build 100 reactor units have been cancelled. As a result, the amount of lead used in radiation shielding has declined significantly.

FIGURE 25
U.S LEAD CONSUMPTION



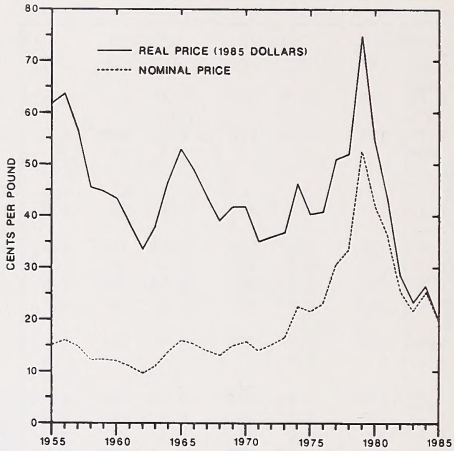
Source: Bureau of Mines, Various Years.

FIGURE 26
U.S LEAD DEMAND



Source: Bureau of Mines, Various Years.

FIGURE 27
U.S PRODUCER PRICE OF LEAD



Source: Bureau of Mines, Various Years.

Prices

Since a small number of companies are responsible for a large percentage of the U.S. mine output of lead, the domestic prices of lead are set by the major producers. The U.S. producer price is typically several cents per pound above the London Metal Exchange (LME) price, but, in order to prevent the loss of domestic markets to imports, the difference is usually not large enough to cover the costs of freight, insurance, import duties, and dock handling.

After a slight increase in 1984, prices resumed the downward movement evident since 1979 (Figure 27). The average price in 1985 was 19.1 cents per pound, the lowest in real terms in the last 30 years. In 1986, excess stocks of lead were reduced as a result of the closing of the Buick lead mine in Missouri, as well as the shutdown of some mines producing lead as a byproduct. With LME stocks also declining, prices eventually stabilized and began to increase. By the latter part of 1986 the U.S. producer price was in the range of 28 to 29 cents per pound.

Outlook

The U.S. Bureau of Mines has forecast lead demand in the year 2000 to be 1.6 million metric tons, which would represent an average annual increase of 2.2% from the 1985 consumption figure. Given the weakening demand for lead over the past years in many different sectors, as well as the lack of evidence of any major new applications on the immediate horizon, this rate of growth is probably overly optimistic. Nuclear power will continue to be at a cost disadvantage when compared to other fuels, so there is little prospect for a resurgence in nuclear power plant construction activity and the associated demand for lead in radiation shielding in those plants. The demand for lead in other construction applications (roofing, bearing pads and sheet lead for vibration damping and noise abatement) could remain fairly stable or increase somewhat.

The Department of Energy (1986) has developed long-term forecasts of world crude oil prices under several different scenarios. In all cases, prices are in a range of $24 to $32 per barrel by 1995 (in constant 1985 dollars). Even at the high end of the range, crude oil prices, in real terms, would still be more than 25% below the levels reached in 1981. Thus, with respect to the demand for lead in transportation, there will be little incentive to switch to electric vehicles for general public use. The demand for traction batteries may rise, however, so the total consumption of lead in transportation will probably continue to increase, but at a slower rate than experienced in the past. The domestic market for lead as a gasoline additive will eventually disappear, as will the export market, once other countries act to restrict airborne lead emissions.

The demand for lead in the electrical and oxides/chemicals sectors will probably remain small relative to the transportation industry. However, there will be an increasing need for lead for television glass, anti-corrosion paints and uninterruptible power supply systems. Thus, on the whole, a rate of increase in domestic lead demand of something less than 1% per year would not be surprising. The consumption of lead in the rest of the world will probably grow at a slightly faster rate.

Domestic resources should be more than adequate to satisfy the expected cumulative demand for primary lead in the U.S for at least the next 20 years, even if imports were reduced. A study published by the Bureau of Mines in 1983 analyzed the potential availability of lead from 14 primary lead deposits in the United States. As of January 1982, production was occurring from 9 of these deposits (4 of the remaining 5 deposits were in Missouri, but outside the study area). For 6 of the 9 producing operations, the long run total costs were estimated to be no more than $.32 per pound (equivalent to about $.36 per pound in constant 1985 dollars). At that cost, 10.3 million metric tons of lead would be potentially recoverable. An additional 6.1 million metric tons would be available from both producing and nonproducing deposits at a cost of $.46 per pound (1985 dollars). The results were shown to be relatively insensitive to changes in byproduct prices which are generally lower now than they were in 1982. The cost estimates were based on a discounted cash flow analysis of mine and mill operating expenses, as well as capital outlays for exploration, acquisition, development, and mine and mill plant and equipment. Capital costs were adjusted to reflect investments made before 1982, and a discount rate of 15% was used.

Considering probable import levels, the expected slow growth in demand and the anticipated increase in the percentage of U.S. lead consumption which will be met by the recovery of old scrap, demonstrated resources in domestic primary lead deposits already in production should clearly be sufficient until sometime beyond the end of this century. For the rest of the world, lead resources also appear to be adequate to satisfy cumulative demand to at least the year 2000.

SOCIAL ENVIRONMENT

The six-county analysis area (Figure 18), lies within the Missouri Ozarks region. The Ozarks region is well-known to both Missouri and the Nation, and is characterized by its rugged terrain, rural environment, cultural heritage, and the Ozarker's consciousness of place.

The social environment of the analysis area is described in terms of its demography, lifestyles, attitudes, beliefs and values, and social organization. Most of the potential social impacts resulting from any mineral activities would occur within this six-county area. Although the focus of the analysis will be on the six-county area, information will often be presented for individual counties or towns. Comparisons to the Ozarks Region and State will be made where appropriate.

DEMOGRAPHY

As of 1985, around 2% of Missouri's population resided within the six-county area. Population density averages 22 people per square mile, compared to the statewide average of 71 people. The lowest density occurs in Shannon County with 8 people per square mile, while Butler County has the highest at 54 people. The area is distinctly rural. Most people, 74%, are rural residents. The largest urban population is the City of Poplar Bluff, in Butler County with a 1984 population of 17,281. West Plains, in Howell County is the next largest with a 1984 population of 7,881. Other communities, which are the primary centers for employment, services, and trade include Mountain View, Willow Springs, Alton, Thayer, Winona, Van Buren and Doniphan.

The analysis area is predominantly white (97%) and most people are of European descent. Ethnic ties exist in the rural communities, but are not a unifying force in the analysis area as a whole.

Minorities constitute three percent of the population. The black population, (1%) is the largest minority but is much less than the Statewide average of ten percent. The Black populations are concentrated in the larger urban areas of the State. American Indians are the second largest minority, even though they comprise much less than one percent of the population.

The median age of area residents is 34 years, compared to 31 years for the State. The distribution of males and females shows an almost even split across the six counties.

Table 20 shows the age-class distribution of the analysis area populations as compared to the State. The local area has distinctly larger populations of people under 20 years of age and those over 55 years of age. This is probably best explained in that in most areas of the country, people with lower incomes, as in the case of the six-county area, have a greater number of children. The higher percentage of older people reflects a migration to rural areas, perhaps for purposes of retirement. Table 20 is also suggests there is an emigration of younger age groups (20-35) from the analysis area. The emigration of the younger age-classes from rural areas has been the trend for several decades.

TABLE 20
PERCENT AGE-CLASS DISTRIBUTION

Age-Class	Percent In Analysis Area	Percent In State
Under 20	51	32
20-35	20	24
36-40	21	21
41 +	27	23

Source: U.S. Bureau of Census, 1980.

LIFESTYLES

Lifestyles are patterns of work and leisure, customs and traditions, and relationships with family, friends, and other community members. The study of such complex relationships requires an analysis of the levels of education, occupations and skills, types of employment, family incomes, and the relation- ship of the lifestyle to the land.

Education

The statistics on education are typical of the Ozarks in that the level of formal education completed is lower than in other areas of the State. This results, in part, from an older age of the population that has fewer years of formal schooling completed and a lower emphasis on formal education.

Based on the 1980 U.S. Census statistics, the median years of school completed for persons 25 years old or older is 11.4 years. This compares with 12.4 years for the State. Further analysis indicates that only 47.5% of persons are high school graduates, compared to the State with 63.5%. At a higher level, the percent of analysis area persons with four or more years of college is 7.2%, compared to the State at 13.9%.

Occupational Structure and Employment

Table 21 summarizes the percent of population by occupation as compared to the State. Although the analysis area is predominantly rural, it has a wide variety of occupations, and a greater variety than most other rural areas in the State. Because it is rural, it has a lower percentage in the "professional/ managerial" category. However, the percentage is higher than for the average rural area. This could be attributed to the physical and geographical landscape which may attract some people in this category.

TABLE 21
PERCENT OF POPULATION BY OCCUPATION

Occupation	Analysis Area	State
Professional, Tech., & Managerial	18.6	29.0
Technical, Sales, & Support	24.3	27.0
Service	15.4	12.2
Farming	11.2	3.8
Machine Trades & Processing	14.1	10.9
Operators, Laborers, & Fabricators	28.1	17.1

Source: U.S. Bureau of Census, 1980.

The six-county area has a much higher percentage of persons in the "operators/fabricators" category and in the "farming" category, which is typical for rural areas. The percent of "service" occupations is higher than both the State averages and averages for rural areas in Missouri.

The individuals applying for jobs in November 1986 indicated available skills across all occupational categories. This indicates that although the local area has a lower level of schooling and is distinctly rural, the people have a wide variety of occupational skills.

Table 18 of the "Economic Environment" section summarizes employment by primary industrial sector in the analysis areas. Determined from Table 18, the analysis area, except for government services, is similar to the State in terms of percent of persons employed by the industrial sector. This indicates that even though the analysis area is rural, it has an economy that is nearly as diverse as the State.

Family Income

Family income in the analysis area, as well as the Ozarks as a whole, is considerably lower than the State. The median family income in 1979 for the area was $11,350. This is 40% below the State median income of $18,784 and 28% below the Statewide average for rural areas. The median income ranges from a low of $9,900 in Ripley and Oregon Counties, to a high of $12,500 in Butler County.

As of 1980, around one-third of the families in the area receive Social Security income. This compares to 26% Statewide. This is primarily due to the larger population of older persons on fixed incomes in the analysis area.

The lower family income level is probably attributable to a lower wage scale, and the fewer number of higher salaried jobs in this rural area. Although incomes are very low in the six-county area, the cost of living is also less, and therefore, the differences in the standard of living are not as great as what the figures may indicate.

The percentage of families whose income in 1979 was below the poverty level was 20.4%, as compared to 9.1% for the State. This percent ranges from a low of 17.6% in Howell County, to a high of 24.8% in Ripley County.

Lifestyles and the Land

The Ozarks are unique because of the physical landscape and how the people's lives are integrated with it. The relatively rugged terrain, karst features, natural springs, clear spring-fed streams and rivers, forest resources, and remoteness have a tendency to penetrate a person's "mind and heart." It is this phenomenon which has affected the lifestyle, hence, the culture.

The land has been the primary force influencing the lifestyles of the people. The land continues to affect their lifestyles today. The land and its natural resources have provided a modest, but steady income and employment. This has formed the basis for the

area's economy which centers around farming, forest product processing, river recreation and tourism. Additionally, the lands rugged terrain, remoteness and beauty have provided solitude and other outdoor opportunities.

VALUES AND BELIEFS

Typical of the Ozark's Region, the residents of the analysis area value their lifestyle for many reasons. The residents maintain strong beliefs in the values of rural living. Rural living implies simplicity and peacefulness to some, and rudeness or "lack of polish" to others.

The local inhabitants have a close relationship to the land. Land is valued for providing their economic livelihood and quality of life. There is an appreciation for the natural resources but at the same time an attitude to both utilize and conserve the land.

The people value their cultural heritage. Although cultural changes have occurred, values have not changed from those of the early settlers and immigrants. They still value independence, self-sufficiency, resourcefulness, courage, and the ability to persevere. Perhaps, because of the rural life and remoteness of the area, residents value their "sense of place." They think of themselves as "Ozarkers" and others as "outsiders."

Most of the residents are white and of European descent. The ethnic cultures present in the area are German, Irish, and English. A review of the churches in the area indicates that the majority (90%) are Protestant.

Finally, the "Ozarkers" value family and kinship relations. Closeness of family is an Ozark characteristic, dating back to earliest settlement of the region. Extended family ties play a large role in emigration patterns, politics, employment, value system formation and social activities. The family reunion is a common and important event in the region.

ATTITUDES AND CONCERNS

Because mining activities in the analysis area would directly and indirectly influence the local economy and social setting, citizen perceptions, attitudes, and concerns toward mining will be discussed. These attitudes were assessed by reviewing the public comments of all respondents from Forest Service environmental documents and from recent public meetings related to future mining activities in the area. It should be understood that the objective is to identify the salient issues related to mining and that the public comments reviewed may not be a representative sample from the public at large.

An analysis of the comments suggests the commentors are split into three different viewpoints. The first viewpoint maintains strong sentiments toward protecting or preserving the natural environment of the study area and the Ozarks. Some of the more basic perceptions of this group are: clean water is a valuable commodity and must be protected; threatened and endangered wildlife and plant species must be protected and the effects of mining fully analyzed; jobs from mining are temporary, but land and water are permanent; and the scenic and recreational values of the area are the major reason people have chosen either to move here from other areas or stay here in spite of high unemployment and the poor economy.

In contrast, the second viewpoint emphasizes that economic development, jobs, and the economy are of the highest priority and should be encouraged. Some of the more basic perceptions are: mining will not harm wildlife; mining is vital to the Nation's well-being; the existing high unemployment and the poor economy will benefit from mining jobs; and many mining effects are short-lived and can be mitigated, therefore, there would be little effect on the land character.

The third viewpoint supports mining activities and development, but only if the natural environment could be protected. Those maintaining this view have an interest in seeking a technological solution to the problem and would favor a balanced land use policy to satisfy all people.

The residents of the Ozarks and the analysis area maintain strong values over land use as a result of their lifestyle and heritage. Thus, when examining State and Federal land management decisions in the Ozarks and surrounding areas, the residents scrutinize the impacts on what they view as their heritage and the heritage of future generations.

SOCIAL ORGANIZATION

Community Stability and Cooperation

Community stability and cooperation relate to the ability of a community to accommodate and manage change, as well as the degree of unity and cooperation that exists among the people within the community. Community stability and cooperation are weakened when changes are disruptive enough to interfere with community efforts to solve problems and meet the needs of residents. Depending upon the extent of mining activities in the study area, both community stability and cooperation could be disrupted.

The economy of the six-county area is nearly as diverse as that of the State. It is generally reliant on government, manufacturing (wood products, food processing and apparel), and retail trade and services which result from recreation and tourism. The land and its resources have been the primary factor in maintaining the long-term economic stability for most communities. Although unemployment in the short-term has fluctuated, it has moved in the same direction as the national economy.

Depending upon the extent of new mining activities, long-term economic stability could be disrupted. New mining activity would

establish a primary base industry that currently does not exist in the area. This industry would create new jobs, potentially reducing unemployment, and directly and indirectly effect the inter-relationships of other industries in the area. For example, the higher-paying mining jobs might attract people from the wood-products industry, causing disruption to that industry. Similar effects might occur in other economic sectors. The significance of any economic disruption, however, would depend upon the extent of the mining activities.

As discussed under attitudes and concerns, opinion vary among residents of the analysis area does occur. Although it is difficult to explain, the discord is usually a result of differences in beliefs, lifestyle, values, and other opinions. Because of the values area residents place on the land, disagreement often arises over the appropriate use of the land and the natural environment. Conflicts may arise over specific project proposals such as mining developments, forest management practices, or use of the Eleven Point and Current National Scenic Rivers. Although residents value their independence and are known to voice their opinions, the realities of life are recognized. The people have learned to cooperate when differences occur.

Social Institutions

Social institutions include the family, churches, schools, businesses, and government. These institutions are important aspects of the social environment in that they are usually sensitive to changes. These institutions, if impacted, usually affect both the economy and culture simultaneously.

Family

The family is an institution that is highly valued in the analysis area. The 1980 U.S. Census figures showed that the family size of for the area averages 3.1 persons per family, as compared to 3.2 persons for the State. Family size is nearly consistent across all counties. Married couple families constitute 89% of all families, as compared to 85% Statewide. Families in which there is a female householder with no husband present, constitute 2.6% of the families. This is much lower than the State average of 12.2%, and lower than the average for rural areas in Missouri which is 6.6%. These statistics, at least in part, support the local area values held toward families.

The percent of divorces for all marriages in the six-county area was 21.6%, compared to 24.5% Statewide in 1980. Although the percent of divorces is less than the State average, the difference is not significant.

Church

A review of 18 communities indicates that there are over 65 churches, of which 90% are Protestant, 5% Catholic, and 5% other. There is an adherence to religious fundamentalism.

Although the number of churches and their influence have declined over the years, the church still plays an important role in the life of the Ozark people. Church attendance and activities provide opportunities for worship, prayer and fellowship with neighbors. Revivals are not as popular as in the past but are still a part of the people's lifestyle.

Schools

Enrollment for elementary and secondary schools in the six-county area was around 23,000 in 1980, but declined to around 21,700 by 1985. This represented a decline of 6.1%. Shannon County experienced the greatest decline of 14.4%, with Ripley County having the lowest decline of 0.1%. Except for Oregon County, the decline in school enrollment has occurred despite an increase in the population from 1980 to 1985. A similar trend has occurred Statewide.

The majority of elementary and secondary schools in the area are public. The counties of Howell and Butler have a few private schools. The nearest colleges for most residents are Southwest Missouri State University Campus in West Plains, and Three Rivers Community College in Poplar Bluff. Vocational education is available at the Vo-Tech centers in Doniphan and Poplar Bluff.

Elementary schools have an average student/teacher ratio ranging from 13/1 in Carter County to 10/1 in Butler County. The junior-high and high schools have an average student/teacher ratio of 12/1 in Carter County to 16/1 in Howell County. The ratios for private schools are much less. Given these ratios, most schools could accommodate additional students.

Business

A review of the larger communities in the analysis area indicates there are 15 available industrial sites with a total acreage of around 1,000 acres. There is at least one site in every county. These sites provide opportunities to locate future businesses and industries. Over half of the communities have comprehensive city plans which provide future city planning direction.

Housing

In 1980, there were approximately 43,000 housing units of which 98% were considered year-round dwellings. The less populated counties like Shannon and Carter have fewer dwellings. The number of people per dwelling averaged between two and three in all counties. The median value of homes in 1980 was $23,500, which is much lower than the Statewide average of $36,700.

The standard of housing is generally lower in comparison to the State. Seven percent of the year-round houses in the area lack plumbing for

exclusive use. This compares with 2% Statewide. In terms of the number of rooms per house, the median number is around five for both the local area and the State.

The six-county rental vacancy rate averaged around 11%. This is slightly higher than the State average. The 1980 median monthly rate was around $95, which is much lower than the State average of $150. The standard of rental housing units is somewhat lower, however, since the homes are smaller, averaging four rooms in size.

Community Services

Community services such as municipal water supplies, wastewater treatment, law enforcement and medical facilities can also be sensitive to changes in population or economic development. Depending upon the extent of the mining activities in the study area, community services could be impacted if the demand for them exceeds design capacity.

Water

The municipal water supplies for most communities in the analysis area are provided by wells. The Black River serves as a municipal water supply for Poplar Bluff. The water capacity in gallons per day varies greatly by community, but the average daily capacity in most communities is greater than average consumption. As an average for the six-county area, daily water consumption is around 33% of capacity. Depending upon the community, this percentage may range from 10% to 65%. Peak water consumption averages around 47% of capacity and ranges from 15% to 80%.

Wastewater Treatment and Solid Waste

Wastewater treatment is highly variable depending upon the community. The type of facilities used include lagoons, oxidation ditches, mechanical treatment, or secondary treatment. Around 22% of the communities do not have any wastewater treatment. Depending upon the community, the treatment capacity may vary from 30,000 gallons per day to over 3 million gallons. Generally, the treatment facilities operate at 44% of their daily potential capacity.

Solid waste disposal is available in nearly all of the larger communities. The majority of the communities provide it as a public service, with a few contracting it out to private businesses.

Fire and Law Enforcement

Most communities have a fire department to protect residences and businesses as well as the communities and outlying rural areas. Since these communities are small, fire departments are usually staffed with volunteers. The size of the volunteer staff averages around 12 people. About 11% of the communities have a full-time fire department staff.

The county sheriffs' departments average 5 officers, ranging from 3 to 18 officers. The smallest communities rely upon the county sheriff's department for local law enforcement.

The Mark Twain National Forest has a cooperative law enforcement program with the State and local counties to enforce administrative regulations on National Forest Lands in the study area. The Forest also has an extensive fire protection program to protect the Forest lands from fires.

Hospital Care and Medical Personnel

In the six-county area there are six hospitals with over 900 beds. There is approximately one bed for every 100 people. The average distance to the nearest hospital for most residents is 20.5 miles. The communities in the area are supported by over 140 medical personnel, which includes over 95 licensed doctors. The analysis area averages nine licensed doctors per 10,000 people, as compared to a Statewide average of 15 doctors. Additionally, there are over 30 dentists servicing the area.

County Revenues and Taxes

There are three major sources of county revenue: property taxes, the 25% Fund and Payments in Lieu of Taxes (PILT). Table 22 summarizes the 1984 property taxes for the analysis area and the State. The table shows that per capita property taxes of the area are considerably lower ($83 per person) than the State taxes ($263 per person).

TABLE 22
PROPERTY TAXES, 1984

County/ Area	Assessed Valuation (Mil. of $)	Total Property Taxes Levied	School Taxes % of Propty. Taxes	Per Capita Propty. Taxes
Butler	88	$3,899,305	58.6	$102
Carter	10	370,972	47.4	66
Howell	55	2,363,215	63.7	78
Oregon	21	838,573	59.4	83
Ripley	19	654,010	43.0	51
Shannon	16	600,997	59.7	75
Analysis Area	209	8,727,072	58.6	83
State	20,944	1.3 Billion	62.1	263

Source: Taspayers Research Institute of Missouri, 1986.

Counties with National Forest System lands within their boundaries receive 25% of Forest Service gross receipts. These receipts come from timber sales, special use permits, recreation and grazing fees and mineral leases. Use of these funds is constrained by the stipulation that the counties use these monies to support school and road programs. Payments from the Forest Service 25% Fund may vary annually, depending upon Forest Service management operations and receipts collected.

PILT payments are made by the Federal Government to those units of local government that are the principal taxing bodies and providers of services in a local area. In most states, these are counties. Unlike the "25% Fund," PILT payments can be used for any governmental purpose.

In 1985, the Mark Twain National Forest returned 5.3 million dollars in receipts to the U.S. Treasury. Mineral rents and royalties accounted for 57% of these receipts or 3.1 million dollars. Although this percentage is relatively high, it is lower than the 1976-1984 period when the percentage averaged 81%.

A portion of mineral rent and royalties is returned to the counties through the 25% Fund. The fund returned 1.3 million dollars in 1985 to counties containing National Forest System lands in Missouri. Mineral rents and royalties accounted for a significant portion of total county receipts. In addition, PILT payments to counties based on National Forest land was 0.7 million dollars for a total payment of 2.0 million dollars. Table 23 summarizes the 1985 National Forest 25% Fund and PILT payments to counties.

TABLE 23
25% FUND AND PILT ALLOCATIONS, 1985

County/Area	25% Fund	PILT	TOTAL
Butler	$44,433	$20,239	$ 64,672
Carter	82,810	44,118	126,928
Howell	44,986	22,868	67,854
Oregon	90,197	45,965	136,162
Ripley	87,531	44,422	131,953
Shannon	78,897	45,818	122,715
Analysis Area	428,854	223,430	650,284
State	1,300,000	700,000	2,000,000

Source: Missouri Department of Natural Resources, 1986.

TRANSPORTATION SYSTEM

The existing transportation system provides access through and around the study area. It ranges from good to poor, depending on the types of roads involved. Federal Highway 60, a major high-speed east-west artery, borders the area on the north. Federal Highway 160 is another east-west artery just south of the area. It is more sinuous, requiring a slower average speed than Highway 60.

State Highways 99, 19 and County Road J are hard surface north-south arteries which link with the two Federal highways.

A network of Forest Service roads and county roads access the area between the major highways. In addition, there are numerous "woods roads" throughout. Driveability ranges from seasonal to year-round. Some of the roads on National Forest System lands are scheduled to be closed while a few are scheduled to be upgraded.

CHAPTER FOUR

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This Chapter describes the environmental consequences of implementing five alternatives for Federal hardrock mineral leasing in the study area. The alternatives were developed in response to public issues and management concerns about possible mineral activities that may result from leasing.

There are six sections in this Chapter. The first section describes environmental effects of implementing the Forest Plan (Alternative A: No Leasing). It discusses how the study area landscape will change as the Plan is implemented. Forest Plan activities, though not within the scope of this analysis, are the basis under which all future mineral activities would be added. Combined, the effects of implementing the Forest Plan and issuing mineral leases would equal the cumulative effects resulting from a leasing decision.

The next section describes the environmental effects of implementing the leasing alternatives. The effects are described by resource in the same order as they appear in Chapter Three. The section also discusses various mitigation measures to reduce or eliminate specific effects that may result from a particular mineral activity.

The remaining sections are summaries and analyses of the effects. These include a summary of mitigation measures, unavoidable adverse effects, irreversible/irretrievable effects, short term/long term effects, and cumulative impacts.

FUTURE NON-MINERAL ACTIVITIES

Implementation of the Forest Plan will result in the occurrence of several non-mineral activates in the study area over the next ten to fifteen years. These activities and the standards under which they could occur are identified in the Plan. Actual implementation depends upon several factors, including funding, additional information and further environmental analysis. Although this EIS is not reevaluating Forest Plan activities, these activities, in combination with mineral-related activities, are the basis for evaluating cumulative effects for Alternatives B, C, D and F.

The Forest Plan identifies twelve different multiple use management prescriptions, each with specific standards to ensure protection of resources. The prescriptions identify which resources will be emphasized, and to what degree, in various habitats across the Forest. The study area includes four of these prescriptions.

Under Forest Plan prescriptions, over the next ten years, the study area is anticipated to provide from 50 million to 80 million board feet of timber, 400,000 recreation visitor days, 2600 acres of wildlife habitat improvement and 800 acres of range improvement. This will require constructing, reconstructing, or maintaining about 230 miles of road and will affect about 15,000 acres.

Management prescription 3.4 emphasizes wildlife habitat diversity. Area under this prescription is known as a Management Area 3.4 and will be managed to maintain and enhance populations of native and naturalized wildlife species. Forty-four percent of the study area is under this prescription. Dispersed recreation opportunities are emphasized, as well as providing timber products, forage and mineral commodities. Generally, road density will be two miles or less per square mile of National Forest lands under this prescription. Specific standards are in pages IV-115 to 124 of the Forest Plan.

Management prescription 4.1 emphasizes shortleaf pine management and dispersed recreation in a roaded environment. Forty-two percent of the study area is under this prescription. The prescription allows for production of hardwood timber, fish, wildlife, forage and minerals. Road density will not normally exceed two miles per square mile of National Forest lands. Specific standards are in the Forest Plan, pages IV-125 to 132.

Management prescription 6.2 constitutes 10% of the study area. It emphasizes motorized semi-primitive dispersed recreation in a natural setting. It also provides an opportunity to improve wildlife habitat common to natural communities, and to produce low or moderate levels of other resources. Road density will not exceed an average of one mile per square mile of National Forest lands. Specific standards are in the Forest Plan, pages IV-175 to 184.

Areas under the management prescription known as Management Area 8.1 comprise four percent of the study area. Prescription 8.1 emphasizes

protection of environmental, recreational, cultural or historic special areas. Other activities will only be permitted if they are compatible with management of these "special areas". Individual areas are typically less than 100 acres, with the exception of 19 miles of the Eleven Point River which flows through the study area.

PHYSICAL ENVIRONMENT

SOILS

The primary effect of mineral activities on soils would be loss of productivity due to erosion or soil contamination. Erosion can result from clearings for roads, drill sites, mine facilities, tailings impoundments, and powerline rights-of-way. Soil contamination can occur when ore dust escapes from mills or haul trucks, tailings spill onto soil or seep into water, exhaust is vented from mine from vent shafts, or drilling effluent is spilled. Lost soil productivity would vary by the level and location of activity. In general, however, the more land disturbed, the greater the risk of erosion; and the more lead mined, the greater the risk of contamination.

The effects of mineral activities on soils are organized by scenarios rather than by alternative.

Erosion

Forested lands are subject to a natural erosion rate of about 0.1 ton/acre/year (Patric, 1976). Any activity that disturbs the forest floor and exposes mineral soil has the potential to increase erosion above this natural rate. How much soil erodes depends upon a variety of factors including location, climatic conditions; the type and duration of activities; and reclamation. Most soils in the study area are only slightly to moderately erosive and recover rapidly once an activity is completed and revegetation begins.

As a result of activities under the exploration scenario, it is estimated that 4 acres would be disturbed for access roads, and up to 26 acres for drill sites. The drill sites would be less than a half acre in size, and dispersed throughout the study area. These areas would be disturbed for about six months, after which they would be reclaimed. Access roads would be reclaimed immediately after drilling operations were completed. Exploration activities would occur over a six year period.

The effects of exploration on soil would vary by location. If drill sites were located on steep side slopes, there would be greater risk of erosion than if they were located on ridge tops (Vowel, 1985). Further, if drill sites were built on highly compactable soils, there would be a greater risk of compaction than if roads or drill sites were located on soils with a high rock content. The magnitude of effects would vary by intensity or type of activity.

In spite of these differences, exploration activities would have limited and very isolated impacts on soils. These activities might contribute as much as 780 tons of eroded soil per year over the entire study area for one to two years following reclamation. This is less than a one percent increase above normal erosion. Thereafter the erosion rate would return to natural levels. The effect of erosion would be insignificant over the study area. This is an insignificant amount because it would be scattered over scores of different sites.

The effects of exploration activates on soil erosion would not vary by alternative.

The potential impacts of low and high development are combined because mineral activities which would occur are the same. However, there would be more activities occurring under high development. Development activities would disturb from 200 to 1100 acres of land, depending upon the number of mines needed to develop the ore. This includes roads, vent sites, powerline rights-of-way mine/mill sites and pipeline access. It does not include dewatering ponds or tailings impoundments because it is assumed that these underwater areas would not erode.

Like exploration, the erosion potential of disturbed areas would vary by location, type of activity and condition of soil; but would be greatest during construction. Then, depending upon the success of reclamation, the erosion rate would return to normal within one to two years after construction. These activities might increase total erosion by 9000 tons per year over the study area (approximately 8 tons per acre disturbed per year). However, this is less than one percent of normal erosion.

Upon closing of the mine/mill, developed facilities would be removed and the site restored to a condition similar to the original natural condition and revegetated. Natural soil forming processes would be restored for all areas except the tailings impoundment and perhaps the dewatering pond.

After completion of mining, the tailings impoundment would be reclaimed according to Forest Plan standards. Unlike other areas disturbed by mining, revegetating tailings impoundment may be of limited success over the long term. Tailings since the material is not soil and does not contain those elements of soil that support a natural nutrient recycling system which sustains vegetation. If not successfully vegetated and reestablished, tailings could well serve as a continual source of sediment to streams and, perhaps, subterranean drainages. Estimated erosion resulting from activities under the high development scenario are displayed in Table 24.

TABLE 24
ESTIMATED SOIL EROSION

Activity	Acres	Erosion Ton/Acre/ Per Year	Total Erosion
Drill site access	120	.09	10.8 ton
Drill sites	640	30	1,920 ton
Mine/mill access	96	.18	17.3 ton
Mine/mills	240	30	7,200 ton
Tailings ponds	2,000	1/	1/
Mine water ponds	160	1/	1/

1/ No estimate is made for sedimentation from this source.

Source: USDA-Forest Service, 1987.

Although the location of facilities would differ between alternatives, the kind, size and number of facilities would not change. Therefore, the effects of development would be the same for Alternatives B, C, D and F.

Mitigation Measures

There are several Forest Plan standards designed to minimize the impact and duration of soil disturbances.

Design and locate facilities to reduce disturbance and facilitate reclamation. When possible, locate on ridge tops or gentle slopes. Avoid wet areas and fragile soils. If facilities must be located on steep slopes or fragile soils, include drainage features to reduce length of exposed slopes and revegetate cut and fill slopes.

Design and locate facilities to allow natural water flows. Erosion most often occurs because activities alter natural flows. The Forest Plan includes several different drainage designs for roads and clearings to avoid soil erosion by maintaining natural flows (pages IV - 71, 72, 83).

Reclamation plans will include provisions for immediate stabilization and meeting Forest Plan objectives. There are several reclamation standards in the Forest Plan (pages IV - 71, 72, 83). In general, they are designed to reshape the land to ensure stable drainage and quick revegetation. The addition of soil amendments and fertilizers applied periodically will ensure adequate nutrient availability to maintain long term vegetative cover.

Effects After Mitigation

These standards have been used successfully to keep erosion from roads and small clearings to acceptable levels. If sites are reclaimed properly, erosion rates return to normal within one or two years of disturbance (Lawson, 1985).

Soil Productivity

In addition to the effects of erosion, development activities may result in heavy metal pollutants from fugitive dust or tailings leakage, exhausts from vent shafts, or drilling effluent spillage. If heavy metals did contaminate the soil, the effects would extend beyond the immediate area of disturbance.

In a heavily forested area, heavy metal pollutants are concentrated mainly in leaf litter. Very little is found in the underlying soil. Evidence indicates that significant amounts of heavy metals are leached out of the leaf litter and removed from the area, probably during periods of heavy rainfall and surface runoff, and eventually enter streams. Heavy metal pollutants remaining on site in abnormally high concentrations can be toxic to some plants (Wixson, 1974).

Tailings disposal represents the greatest risk to soil productivity, both because of the immediate large scale impact and the long term reclamation costs. Tailings generally lack basic nutrients, Necessary for plant growth and may have some metals in such high concentrations that they are toxic to some vegetation. In the Viburnum Trend, tailings were found to contain, on the average, 320 ppm lead, 8 ppm cadmium and 500 ppm zinc (Wixson, 1974). Further, traditional tailings disposal methods affect large continuous areas. It is difficult for vegetation to invade and begin "natural reclamation" of the area, because of draughty conditions and low nutrients.

Soil contamination can also result from exhaust fumes or aerosols from mine vent shafts which are located throughout the mined lands. They draw fumes from the mine, and exhaust them at the surface. The exhaust consists mostly of water vapor and diesel fumes. This effects plants and reduces soil productivity. In the Viburnum Trend, soil productivity has been reduced for up to 500 feet around some mine vents.

Drilling effluents also represent a risk to soil productivity. If not disposed of properly, effluents may result in a very localized loss of productivity in small areas. These effluents, when absorbed by the soil, can create a soil chemistry condition unfavorable to vegetation. Many of the elements contained in the drilling effluents are toxic to plants at very low concentrations.

Mitigation Measures

Minimize wind blown contaminants. Cover all stock piles of processed ore and all haul trucks.

On site disposal of drilling effluents. Spread effluent and cuttings away from stream channels and surface drainages.

Control point source pollutants. Construct vents so fumes are vented vertically. Require filtering of all mine exhaust fumes before releasing them to the air.

Effects After Mitigation

The Forest Plan standards will adequately mitigate impacts on the soil resource by short term activities. On a longer time scale, reclamation of the mine/mill area after cessation of activities would also adequately restore the site to a productive condition.

It is unknown whether the tailings pond area can be satisfactorily returned to a productive soil condition over the long term.

WATER RESOURCES

The public raised the issue that mining-related activities would adversely affect the region's water resources. Fears have been expressed that streams and groundwater would be polluted and that springs, wells and aquatic cave-life habitat might be pumped dry.

At one extreme are those who believe mining would inescapably cause these ill effects. At the other extreme are those who acknowledge the potential dangers, but believe that environmentally responsible mining methods rigorously enforced by State and Federal regulatory agencies could prevent them. The issue is explained more completely in Chapter I.

In most ways, the likelihood and magnitude of mineral-related effects on the water resource are much the same for Alternatives B, C, D and E. The main differences in effects occur between the three scenarios within the alternatives. Thus, this section discusses water resource effects by scenarios rather than by alternatives.

Potential effects of mining activities on water resources discussed in this section include:

1. Contamination of surface water and groundwater by drilling effluent, sedimentation, sanitary sewage, tailings, heavy metals, milling reagents, petroleum products, and herbicides.

2. The water resource and related effects of tailings and minewater clarification impoundment failure.

3. Altering of surface water and groundwater flows and lowering groundwater levels.

Before discussing effects, it's important to know that the Missouri Department of Natural Resources' policy is that no degradation of existing water quality will be allowed in the Eleven Point and Current Rivers and waters draining to them. This policy is contained in 10 CSR 20-7.031(2)(A)3, 10 CSR 20-7.031(7) and 10 CSR 20-7.015(6)(C)2.

Drilling Effluent

Contamination of surface water or groundwater by drilling effluents could be caused by discharge of the effluent into flowing surface streams or into groundwater recharge locations such as sinkholes and stream channels which funnel surface water into the groundwater supply.

Effluent from a typical drill hole consist of about 2,000 gallons of water per day containing finely ground rock particles, mud and 36 gallons or less of a frothing agent. A variety of commercial frothing agents may be used. For analysis purposes, Procter and Gamble's Orvus K Liquid has been chosen to represent the chemical composition of such agents. The main ingredients in Orvus K Liquid are:

Ammonium lauryl ether sulfate	38%
Alkanolamide	9%
Unsulfated alcohol	1.2%
Ammonium chloride	1.9%
Denatured ethyl alcohol	20%
Water	30%

The first two active ingredients individually have 96-hour median tolerance limits of 10 and 25 parts per million for bluegills (Procter and Gamble, 1979). Toxicity of the other active ingredients is unknown, but is not thought to exceed the first two. Toxicity of the entire formulation as a whole is not known either.

Water contamination by drilling effluent could occur in all scenarios. All else being equal, the likelihood and potential magnitude of contamination would be greatest in the high development scenario and least in the exploration scenario.

In actual practice, however, how the effluent was disposed of would be more important than how much was produced. A small amount of effluent inadequately disposed of could produce greater effects than a large amount skillfully disposed of. Effluent disposal techniques used in the Viburnum Trend have successfully prevented any adverse effects on the water resource from occurring there.

Mitigation Measures

Discharge of effluents to surface waters in amounts sufficient to cause putrescent, unsightly or harmful bottom deposits, cause unsightly color or turbidity, offensive odor or taste, cause harm to human or animal life, or interfere with beneficial water uses is prohibited by the Missouri Department of Natural Resources' general water quality criteria (10 CSR 20-7.031(3)). Degradation of groundwater quality by drilling effluent is prohibited by 10 CSR 20-7.031. The Forest Plan (page IV-45) requires leases to comply with all State water quality laws and regulations and to minimize water pollution.

On site disposal of drilling effluents. Drilling effluent shall be disposed of in places and ways where it does not reach surface drainage channels or discrete groundwater recharge features such as sinkholes and losing streams.

Effects After Mitigation

Assuming that drilling operations comply with all State water quality laws and regulations, Plan standards and the proposed mitigating measure, there should be no detectable contamination of surface or groundwater.

Sedimentation

Sedimentation of surface water and groundwater could be caused by many different mineral related activities.

Much, though not all, drilling requires that temporary access roads be constructed into unroaded areas and that drilling sites be leveled. These roads and drilling sites would be potential sediment source areas.

Mine, mill, powerline, and road construction would expose large areas of soil. How much of this exposed soil would erode depends on intensity and timing of rainfall, soil characteristics, topography and how long the soil is bare before it is either restored to a protected condition or develops an erosion-resistant chert pavement.

There are many possible effects of sedimentation on the water resource. The most obvious is visually unsightly water turbidity, an especially important factor in the study area's recreational attractiveness. Turbidity also can reduce the feeding efficiency of sight feeding fish species such as rainbow trout and smallmouth bass.

Fine sediment particles which might accumulate on stream bottoms could plug up the spaces in the gravel, degrading the habitat of aquatic invertebrates and reducing the gravel's suitability for fish spawning and egg survival. Massive deposition of fine particles also could reduce the amount of groundwater recharge through coarse, permeable gravels in surface flow-loss areas.

In regard to water quality, erosion would be important only if the detached soil particles reached surface drainageways or places such as sinkholes where surface water recharges groundwater with little filtration of contaminants. If the particles settled out before reaching surface channels or groundwater, they would have no effect on water quality.

Sedimentation can alter water flows by effecting groundwater channels or surface drainages. This could reduce water flow in some areas, possibly lowering water tables and reducing aquatic or cave habitats. It could increase flows in other areas.

Sedimentation could occur in all scenarios. The potential magnitude would be greatest in the high development scenario and least in the exploration scenario.

Mitigation Measures

Soil erosion is considered to be a non-point water pollution source. The Forest Plan requires that non-point pollution be minimized (page IV-45), that sediment filter strips be left between soil disturbance areas and streams (page IV-45), that accelerated erosion be controlled (page IV-47), that sedimentation of waterways be prevented or minimized (page IV-48), that significant soil disturbance is prohibited within 100 feet of significant seeps, fens and springs (page IV-52), that water runoff will be diverted from roads before reaching riparian areas (page IV-54), that drilling is prohibited within buffer zones and on steep slopes associated with perennial waters (page IV-71), that drill sites shall be revegetated (page IV-71), that sediment filter strips shall be left between temporary roads and perennial or intermittent streams (page IV-83) and that temporary access will be closed, stabilized and revegetated when no longer needed (page IV-83). General water quality criteria enforced by the Missouri Department of Natural Resources (10 CSR 20-7.031(3)) prohibit sedimentation which causes unsightly or harmful bottom deposits, causes unsightly color or turbidity, interferes with beneficial water uses, or has a harmful effect on human or animal life.

Effects After Mitigation

Assuming that mineral activities would be conducted in compliance with Forest Plan standards and State water quality criteria, there should be no discernible sedimentation of the water resource, except as noted in the following sections.

Sanitary Sewage

Contamination of surface water and groundwater by sanitary sewage could originate from a variety of mineral activity-related sources.

Sanitary sewage from a mine/mill complex most likely would be treated in a multi-cell lagoon system. Sanitary-sewage treatment and disposal for new homes and businesses attracted to the area probably would be accomplished by a variety of methods. Scattered individual homes most likely would employ septic tanks with absorption fields of varying adequacy. Their usually scattered occurrence across the landscape allows rainfall to dilute the effluent and confine its effects to a very localized area. The water resource most frequently contaminated by individual home septic systems is the home's own drinking water well, many thousands of which throughout the Ozarks are inadequately cased and grouted to exclude contaminants (Duley, 1983).

Four possible effects of sanitary sewage on water are of most concern. Contamination of drinking water supplies and swimming waters by disease-causing organisms such as bacteria is of major concern. Local drinking water is drawn exclusively from groundwater, either from

wells or springs. Swimming is a major recreational use of the area's surface water.

Water polluted with large amounts of sanitary sewage also contains large amounts of chemical nitrates, continuous consumption of which can cause a potentially fatal disease in humans and animals called methemoglobinemia, or "blue baby disease." The nitrates are converted to nitrites in the gut, and the nitrites then rob oxygen from the blood. Although infants are most at risk, adults may also be affected.

In addition to nitrates, sanitary sewage also contains significant amounts of chemical phosphates. Both are vital nutrients for aquatic vegetative growth. Surface waters heavily contaminated with these nutrients often develop algal growths of nuisance proportions.

The decay of organic sewage consumes large amounts of oxygen. If organic sewage decays in surface water or groundwaters, dissolved oxygen can be reduced to levels which are debilitating or fatal to aquatic animal life. Such water also smells bad.

The likelihood and magnitude of water resource contamination by sanitary sewage would be virtually non-existent in the exploration scenario. The low and high development scenarios, however, would involve contamination that could have significant effects.

Mitigation Measures

State water quality regulations require subdivisions, mobile home courts and larger businesses to treat and dispose of their sanitary sewage more adequately than individual home owners. Single or multi-cell lagoons are used most commonly. Properly sited, constructed and maintained, they perform very well. Poorly sited, constructed and maintained, they don't.

Forest Plan standards (page IV-82) require that sewage treatment facilities be designed and operated in compliance with State water quality regulations. State water quality regulations (10 CSR 20-7.015(6)(B)1) forbid discharge of the treated effluent.

Ways to meet the no-discharge requirement include for disposing of the treated effluent by mixing it with the mill-waste effluent for closed-circuit recycling through the ore concentration mill, or by spray-irrigating it onto the land surface away from any streams. Given the hydrogeologic conditions of the study area, siting of lagoons and spray-irrigation systems to comply with State water quality requirements might be very difficult.

Effects After Mitigation

Assuming requirements of State water quality regulations are complied with, there would be no contamination of the water resource by sanitary sewage related to mineral activities.

Mill-Waste Tailings

Mining and milling would produce millions of tons of waste rock. Mineral industry practice in the Viburnum Trend has been to discharge the concentration-mill effluent mixture into multi-hundred-acre impoundments where all but the very finest waste rock particles settle out of suspension and are stored in perpetuity. State water quality regulations (10 CSR 20-7.015(1)(2)). recognize these impoundments as waste treatment devices.

Considering only the waste limestone and dolomite particles and not the heavy metals and milling reagents commonly associated with them, water quality degradation would occur only if these particles escaped from the tailings impoundment.

The greatest possibility for tailings escape would be collapse of the impoundment bottom and flushing of tailings into underground passageways. Lycopodium (club moss) spores with an average diameter of 33 microns are known to enter and travel through the groundwater system with ease (Aley, 1975). Almost 20 percent of tailings particles are this small or smaller (Carter, 1987). It is likely that a much higher percent of tailings could be transported, especially if the collapse occurred into a major groundwater system.

In the Viburnum Trend, erosion on the downstream face of tailings impoundments has been a significant source of water contamination by tailings. Impoundment-face erosion is different than erosion elsewhere, because this surface remains bare throughout its operating life and because erosion-resistant pavements never form on it.

Considering only the dolomite and limestone particles, tailings are nothing more than a special kind of sediment. Most of the effects of sediment have already been described, but an additional effect has been noted in the Viburnum Trend. The very finest tailings particles tend to adhere to the surface of aquatic plant growth, sometimes to the point they cut off enough of the sunlight to kill the plants underneath (Wixson, 1977). This effect is discussed in more detail in the section on milling reagents.

Because mining and milling would not occur in the exploration scenario, there would be no possibility of water contamination by mill-waste tailings. Under low and high development scenarios, however, water contamination from tailings is possible.

Mitigation Measures

Forest Plan standards require that tailings impoundments be operated and maintained in accordance with the Federal Guidelines for Dam Safety (Federal Coordinating Council for Science, Engineering and Technology, 1979) and the other applicable regulations and standards (page IV-82), that tailings-impoundment design

and construction must comply with dam-safety requirements of the Missouri Department of Natural Resources and the Forest Service (page IV-72) and that any tailings impoundment proponent must establish to the satisfaction of the Missouri Department of Natural Resources and the Forest Service that water quality standards will be met (page IV-72). In addition, approval must be obtained for an impoundment operation and maintenance plan in accordance with existing State and Federal regulations. This must include an emergency preparedness response and contingency plan.

State water quality regulations (10 CSR 20-7.015(6)(c)) prohibit discharges from tailings impoundments in the Eleven Point National Scenic River and Ozark National Scenic Riverways drainages. Large tailings impoundments, such as those in the Viburnum Trend, cannot be operated without routine discharges. Thus, without mitigation by major design modifications, it is unlikely that the traditional type tailings impoundments would be permitted in the study area. Other methods of tailings disposal could be used to meet this state water quality regulation. Regardless of the tailings disposal methods used, tailings cannot be discharged in the study area. Some methods to prevent tailings escape are discussed in the section on impoundment failure.

Effects After Mitigation

The successful application of mitigation measures would reduce the risk of tailings escape. However, if an impoundment failed, the effects described above may occur.

Heavy Metals

Heavy metals might escape from the mine/mill site to the off-site water resource in several ways. Although good industrial practices can minimize these losses, they cannot eliminate them completely.

Recovery of metals from the ore in the concentration mill is less than 100-percent efficient and some metals would be discharged along with tailings in the mill effluent. Thus, any escape of tailings would be accompanied by an escape of metals, too. The metals would be primarily in particulate, rather than dissolved, form.

Heavy metals could escape off-site in other ways, too. Spillage and the wind inevitably scatter small amounts around mill sites, tailings impoundments, and along concentrate-transportation routes. Spillage can either be blown off-site, or washed away by rainfall runoff.

Metals washed or blown away can behave differently than ones discharged in the mill effluent. Rainfall, surface runoff and intermittent stormflow in the highest headwater rivulets are often more acidic than groundwater and surface waters lower in the landscape. Thus, some metals might escape as dissolved ions rather than as less available insoluble particulates.

Windblown metals would escape as particulates, but could be dissolved if they came to rest on the forest floor. Humic acids in the decaying leaf litter and humus combine with the metals to make them soluble in rainfall runoff and soil moisture seepage (Wixson, 1977).

Heavy metals would be potential threats to water quality. The metal sulfides and carbonates in the ores are generally insoluble and are relatively nontoxic; however, metals in a dissolved or weakly occluded form may be toxic to aquatic life in very low concentrations. Current water quality standards give maximum concentrations for the protection of aquatic life, drinking water supplies and aquifers. Metals limits, most often for zinc, are occasionally exceeded in the effluent of tailings impoundments in the Viburnum area, although they are probably in a less toxic, insoluble form.

How heavy metals affect living things depends in large degree on whether the heavy metals are in a soluble or insoluble form. Dissolved forms tend to be most directly dangerous, insoluble forms tend to affect living things in indirect ways.

Different life forms have different degrees of tolerance to various metals. For the protection of aquatic life, state water quality regulations limit dissolved copper concentrations to 20 parts per billion (PPB), lead to 50 PPB and zinc to 100 PPB. For human drinking water supplies, however, the limits are 1000 parts per billion for dissolved copper, 50 parts per billion for dissolved lead and 5000 parts per billion for dissolved zinc (10 CSR 20-7.031, Table A).

Research (Wixson, 1977; Schmitt and Finger, 1982) also has shown that insoluble metals accumulate in stream and lake sediments and on aquatic vegetation and can subsequently enter the biological food chain. Discussion of this phenomenon is in the section on consequences to wildlife.

Not all spilled and windblown metals which escape off-site would be threats to the water resource. Many Ozark soils and the residuum underlying them have an appreciable cation-exchange capacity. Research in the Viburnum Trend (Wixson, 1977) has found that dissolved metals percolating downward through the soil are securely bound by clay particles at shallow depth, thereby preventing them from reaching the groundwater.

If animals or humans are exposed to heavy metals, it is possible that acute toxicity could occur. It is more likely, however, that chronic effects would result in genetic disruptions, eventual heavy metal poisoning manifested in the form of nervous disorders, and contaminated flesh of game fish (Self, 1987).

Because mining and milling would not occur in the exploration scenario, there would be no possibility of water contamination by heavy

metals. The low and high development scenarios would, however, possess that possibility.

Mitigation Measures

State water quality standards (10 CSR 20-7.031, Table A) and general water quality criteria [10 CSR 20-7.031(3)] limit both dissolved and particulate heavy metals to harmless levels in surface waters and groundwater. Treatment of mill processing water before releasing it for storage in a tailings impoundment would reduce heavy metal concentrations to within state limits.

Minimize wind blown contaminants. The accidental escape of heavy metals to the off-site environment would be minimized by paving mine/mill areas and periodically washing them down to retrieve fugitive metals, by storing metal concentrates in enclosed buildings rather than in the open, by transporting them in covered rather than open containers, and by the tailings dam safety requirements discussed in the section below on dam failure.

Effects After Mitigation

These measures would reduce, but not eliminate, the possibility of heavy metals entering the water system.

Milling Reagents

A variety of chemicals would be used in the concentration mill to help separate the metal minerals from the waste rock. Although different mills have their own formulations, the following chemicals have been used in the Viburnum Trend (Wixson, 1977):

Methyl Isobutyl Carbinol
Propylene Glycol Methyl Ether
Isopropyl Ethylthionocarbamate
Sodium Diethyldithiophosphate
Sodium Ethyl Xanthate
Zinc Sulfate
Sodium Cyanide
Copper Sulfate
Calcium Hydroxide
Anionic Disodiumsulfosuccinate
Long-chain Aliphatic Alcohols
Sodium Isopropyl Xanthate
Sodium Dichromate
Sulfur Dioxide
Starch
Sodium Dioxide

Several of these chemicals have very perceptible odors and are easily detectable by the human nose in amounts so small they're unmeasurable by laboratory tests. Even if there were no other aquatic effects, the presence of these unnatural odors along nationally significant rivers, like the Current and Eleven Point, would detract from their recreational attractiveness.

These odorous chemicals provide an excellent and inexpensive way to detect the escape of the entire mill effluent mixture, many components of which otherwise would be difficult to detect.

Some of these chemicals are fairly harmless to life, others are highly toxic to both humans and aquatic organisms. Most are somewhere in between.

One of the earliest water quality problems in the Viburnum Trend was a proliferation of algae in streams receiving mill effluent discharges. In the absence of flood flows to dislodge and wash them away, these algal growths would almost literally blanket the streambed. Massive streamers of attached algae would undulate in the current throughout the entire water cross-section. Periodically, these algal growths would die, adding the odor of massive decay to that of the milling reagents.

Although all of the details are not completely understood, research suggests the root cause of these algal blooms is toxicity of some of the milling reagents to aquatic micro- and macro-organisms which normally consume the algae as they grow (Wixson, 1977). With no "grazers" to keep them trimmed back, the algae proliferate uncontrollably. Cutting off the discharge of milling reagents to Viburnum area streams solved the algae growth problem.

Research also has shown that fine sediments, such as heavy-metal and tailing particles, accumulate on algal surfaces, eventually cutting off the sunlight enough to kill algae. The dead material settles to the bottom, smothering the aquatic substrate.

Because there would be no milling in the exploration scenario, contamination of water by milling reagents could happen only in the low and high development scenarios.

Mitigation Measures

Forest Plan standards (page IV-45) require State water quality regulations be complied with. State water quality regulations (10 CSR 20-7.015) prohibit the discharge of milling reagents in the Eleven Point National Scenic River and Ozark National Scenic Riverways drainages. This is accomplished by continuously pumping the mill effluent back through the mill for use as processing water.

Effects After Mitigation

Assuming requirements of the Forest Plan and State water quality regulations were complied with, the only possibilities for contamination of the water resource by milling reagents would be a transportation accident spilling reagents enroute to the mill(s) or a storage accident there. The probabilities of such accidents are small, but real.

Petroleum Products

Petroleum products such as machinery fuel, lubricants and hydraulic fluid would be used in diverse phases of mining and milling. Above ground, they could escape during a transportation accident enroute to the mine/

mill and during storage or use there. Underground, they could escape as spillage in the mine-pumpage water and as an equipment-exhaust aerosol which is vented to the surface.

Experience in the Viburnum Trend has never conclusively proven petroleum products cause significant water quality problems. Early speculation that they might be contributing to the algal proliferation in streams by supplying carbon for photosynthesis never proved out, and more likely causes for the algae were found.

Massive spillage of petroleum products, such as might occur in a transportation accident, probably represents a greater risk to water quality than minor spillage and leakage during use. The duration and severity of effects would depend, among other things, on whether the products escaped directly to surface waters or to groundwaters first. Unlike most other potential water contaminants which are either settleable particulates or water soluble, petroleum products contain both water soluble fractions and lighter-than-water insoluble fractions which float. It's the insoluble fractions which behave differently in surface waters than in groundwater.

Released directly into surface waters, large slugs of petroleum products could cause short duration water quality contamination of possibly high intensity. The water surface and shoreline material could be physically coated with unsightly "scum" and the soluble fractions could have toxic or debilitating effects on aquatic organisms.

As devastating as this might be to recreational rivers like the Eleven Point and Current, however, it soon would pass. Such is not necessarily the case if petroleum products were introduced directly to groundwater.

The water soluble petroleum fractions likely would flush through the subterranean passage system fairly rapidly, but the insoluble fractions could be trapped on the upstream side of siphons in the bedrock passageways. Fluctuating water levels could smear them up and down cave walls behind the siphons over considerable vertical and horizontal distances.

Investigators who have seen this phenomenon in Kentucky caves say that it's quite a mess (Crawford, pers. comm.). How long such an effect might last and to what extent these insoluble fractions might gradually degrade into more soluble break down products in the cave environment, is unknown. The effects might last for years.

Contamination of the water resource by petroleum products could happen in all scenarios. The likelihood would be greatest in the high development scenario and least in the exploration scenario.

Mitigation Measures

State water quality regulations (10 CSR 20-7.015 (6)(C)) permit the discharge of mine-pumpage waters, and these waters normally would contain small amounts of underground petroleum product spillage when they reach the surface. Industrial practice in the Viburnum Trend has been to detain pumpage water in a "minewater-clarification" pond where rock and ore particles can settle out, and petroleum product spillage can biodegrade before discharge off-site. So far as is known, the practice has worked well. Regulations in 10 CSR 20-7.015(6)(C)2 require that minewater-clarification pond effluent must conform to the antidegradation section of 10 CSR 20-7.031(2).

Concerns about tailings impoundment failure also apply to minewater-clarification ponds.

Herbicides

Herbicides would be used to control vegetation on powerline rights-of-way, and perhaps along roadways and around mine/mill sites. Careless transport, storage, and applications, and disposal of containers could contaminate surface water and groundwater. Mineral-related herbicide use would occur only in the low- and high-development scenarios.

Mitigation Measures

Forest Plan standards (pages IV-23, 66 and 67) forbid aerial application of herbicides, require Forest Service approval of proposals to apply herbicides on National Forest System Lands, require compliance with the Federal Insecticide, Fungicide and Rodenticide Act, as Amended, permit only EPA-registered herbicides, require compliance with product labeling, and otherwise regulate the use of herbicides. The Missouri Pesticide Use Act (Chapter 281 RSM.) and rules promulgated under its authority (2 CSR 70-25) require the safe application of herbicides to public and privately owned lands.

Effects of Mitigation

Assuming all of the Forest Plan standards and guidelines, EPA requirements, and State laws and regulations were complied with, there should be no contamination of the water resource by herbicides.

Dam Failure

Dam failure is caused 1) by inadequate site investigation, design, construction, operation and maintenance; and 2) by the occurrence of events, such as floods and earthquakes, more severe than what the dam's design and construction can safely withstand.

In regard to the first category of causes, dams fail in the following ways (National Research Council, 1983):

1. If a dam is constructed over voids in the underlying residuum or bedrock, subsidence can occur. This failure mechanism is normally caused by the weight of the dam. This leads to a collapse of the void ceiling, causing either

gradual or sudden settling of part of the dam into the void.

2. A process called "piping" could gradually tunnel a hole through the dam. Piping is the progressive internal erosion of soil from the downstream side of the dam or foundation backward toward the upstream side to form an open conduit or "pipe". This can lead to a rapid failure of the dam. After piping occurs, preventing seepage from occurring is nearly impossible; therefore, it is imperative that tailings dams be constructed with adequate filters to control the seepage.

3. Dam slopes, abutment slopes, and foundations can become unstable for several reasons. Steep slopes, shallow water tables; excess pore pressures, weak embankments and foundation soils, and poor construction practices all can lead to a slope failure. Most slides occur along a circular or wedge shaped failure surface.

4. If the dam materials are inadequately compacted, drained or sealed, they can become saturated by the impounded water and turn into mud which collapses and flows away.

5. If open-channel spillways are located on fill or erodible abutment soils, high discharge velocities can erode them.

6. Perhaps the most common cause of dam failure is overtopping by unexpectedly large amounts of storm runoff. The principle reason for overtopping is inadequate spillway capacity; however, it can also occur as a result of spillway blockage or settlement and erosion of the dam crest.

The second category of dam failure causes are severe natural events including (National Research Council, 1983):

1. Earthquakes can cause dams to fail in several different ways. Although none of the faults suspected to be in the study area are known to be active, earthquakes caused by shifting faults outside the area are felt here.

2. Storm runoff greater than what the dam and spillway are designed and constructed to safely contain can cause dam failure.

3. Perhaps the least likely cause of dam failure, but one which is known in other parts of the world, is a huge earth avalanche sliding into the lake and sending a towering wave over the dam crest.

The potential consequences of dam failure include:

1. Downstream flooding by water released from behind the dam. Lives might be lost, and property may be damaged.

2. Massive deposition of infertile tailings on more fertile farmland downstream.

3. Channel scouring and/or filling of stream channels with tailings, causing channel instability and erosion, and raising flood levels.

4. Uncontrolled release of milling reagents, heavy metals and tailings which could contaminate surface water and groundwater, and degrade aquatic and riparian habitat.

5. Mortality of fish and other aquatic life.

6. Shut down of the concentration mill, and perhaps the mine, until the dam could be repaired.

There would be no possibility of tailings or minewater-clarification impoundment dam failure in the exploration scenario. The low- and high-development scenarios, however, would possess this possibility.

Mitigation Measures

Forest plan standards require that tailings and minewater-clarification impoundments must comply with dam safety requirements of the Missouri Department of Natural Resources and the Forest Plan (page IV-72), provide for additional requirements to protect public health, safety and the environment (page IV-72), requires dam operation and maintenance in accordance with the Federal Guidelines for Dam Safety (Federal Coordinating Council for Science, Engineering and Technology, 1979) and other applicable regulations and standards (page IV-82), and require dams to be inspected by qualified individuals on a scheduled basis (page IV-82). State dam-safety regulations (10 CSR 22-3.020 and 10 CSR 22-3.04) require new dams be designated to meet minimum slope-stability and spillway-capacity requirements. Detailed plans and specifications for tailings impoundments must be approved by the State and Forest Service prior to construction.

The U.S. Army Corps of Engineers, U.S. Mine Safety and Health Administration, and the Dam Safety Commission of the Missouri Department of Natural Resources also have regulatory authority over dams in the study area.

Public involvement in the early stages of preparing this EIS raised concern about the extraordinary earthquake predicted to occur along the New Madrid Fault in southeastern Missouri within the foreseeable future, and the destructive effect it could have on tailings-impoundments in the study area. Including a mitigating measure such as the following in study area leases could help guard against the destructive forces of this earthquake:

Design and locate facilities to reduce disturbance and facilitate reclamation.

Site investigation using geophysical and hydrologic methods would have to establish beyond a doubt that it would not subside, collapse or leak excessively.

Dam design and construction specifications would have to be such that the structure could safely withstand destruction by the most severe floods, earthquakes and other natural forces that conceivably could occur.

Operation and maintenance of the dam and appurtenances such as the spillway would have to be around-the-clock as long as it exists.

Minimize the amount of water retained behind tailings impoundments to reduce the risk of failure. The goal would be to retain only mill process water and normal precipitation which falls on the impoundment surface. Design and place canals around the impoundment to divert upstream flows, substantially reducing the amount of surface water entering the impoundment. Techniques such as spraying, irrigation and aeration are also ways of reducing the amount of water in the impoundment.

The fate of dams after their use for mining/milling ceases has been questioned. In this regard, a mitigating measure such as the following may included in any study area leases:

> Unless relieved of such responsibility by legal arrangements made subsequent to the issuance of this lease, the lease holder or its assigns shall either maintain dam structures and their appurtenances to their original design, construction and operational specifications in perpetuity or modify or remove dam structures in such a way that they no longer influence the natural hydrologic functioning of the landscape or constitute any conceivable form of risk to downstream property, lives or public health and safety."

Effects After Mitigation

Assuming all laws, regulations, Forest Plan standards and mitigating measures were complied with, the danger of dam failure and its resultant consequences should be virtually non-existent.

Altering of Water Flows and Levels

Surface and groundwater flow rates and volumes, groundwater levels, and groundwater flow directions and resurgence points could be altered in several ways by mineral activates.

Mine and air vent shafts could intercept and block off permanent or intermittent groundwater-bearing passageways. If the shaft were successfully completed through the passages groundwater flow could be diverted to other passages, leading to different discharge points. Groundwater discharge to the surface could be lessened at some points and increased at others.

Pumping of groundwater from the mine(s) could lower groundwater levels. Discharge of the water at the surface could alter surface stream flows. If the water sank back into the ground again, groundwater levels might be raised in the flow-loss area, and flows might be increased at points of groundwater resurgence. Increased water levels and flows at some places, however, would be at the expense of lowered water levels and flows at other places.

Although it is conceivable that exploration drill holes might obstruct very small water bearing passages, the chances of any significant effects seem remote. Thus, the exploration scenario would not be likely to produce any significant effects. The low and high development scenarios, on the other hand, could produce significant effects.

There is no local, state or federal legislation forbidding the alteration of water flows, directions and levels *per se*. A number of Missouri court decisions have established ample precedent, however, that such alterations which cause demonstrable harm to other parties are unlawful.

The likelihood and magnitude of mineral-related effects on water flows and levels would depend on many factors. Groundwater flow in very small passages could be obstructed by mine and vent shafts, causing effects of localized extent. Whether or not they would be significant probably depends more on whether someone or something was adversely affected rather than on the amount of water involved.

Whether or not, and to what extent, springs, wells and cave-life habitat might be affected by minewater pumping would depend primarily on two things. One is how impervious to vertical percolation the Derby-Doerun and Davis Formations are. The other is the hydrogeologic nature of the area where the mine water is discharged on the surface.

If the Derby-Doerun and Davis Formations were so water tight that no water could drain vertically through them, a mine beneath them could be dewatered with no lowering of the groundwater level above. The only thing in danger of drying up might be nearby deep wells which penetrate below the Davis Formation. The nearest such well known is at Ellington, 30 miles to the northeast and well beyond any significant danger.

If the two formations proved not to be water tight, however, mine dewatering would tend to lower local groundwater levels above to some extent. In this situation the hydrogeologic nature of the area where the mine water is discharged on the surface would become important.

Over much, perhaps most, of the area, water moves vertically from the surface to the groundwater zone before moving horizontally out of the area. Localized exceptions undoubtedly exist where surface water moves short distances horizontally before dropping vertically to groundwater. The point is that, in many places, any groundwater-level drawdown caused by mine dewatering likely would be offset by the mine-water discharge sinking back into the ground from above.

Mitigation Measures

Design and locate facilities to allow natural water flows. If shafts intercept groundwater flows through subterranean passages with a cross-sectional area greater than 4 square feet, design of the shafts shall be such that normal groundwater flow will continue.

Effects After Mitigation

Normal groundwater flows will be maintained. The probability of groundwater level alterations would be reduced, but would still exist.

WETLANDS

This section discusses effects which mineral activities might have on the study area's wetlands.

Executive Order 11990 lists the following factors to consider when evaluating a proposal's effect on wetlands:

1) "public health, safety, and welfare, including water supply, quality, recharge, and discharge; pollution; flood and storm hazards; and sediment and erosion";

2) "maintenance of natural systems, including conservation and long term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish, wildlife, timber and food and fiber resources"; and

3) "other uses of wetlands in the public interest, including recreational, scientific, and cultural uses."

The possible effects of mineral activates are discussed for each of these wetland factors. Then Forest Plan standards, and local, state and federal laws and regulations affecting mineral activities and wetlands are discussed. Finally, the likely effects on wetlands are presented if all the regulatory requirements were met. These effects are discussed by level of activity or scenario rather than by alternative.

Public Health, Safety and Welfare

Water supply, quality, recharge and discharge could be affected by a variety of mineral activities.

Exploration activities could affect water quality if drilling effluents were discharged into wetlands. Where wetlands were a result of impermeable soil conditions, such as in sinkhole bottoms like Tupelo Gum Pond, water quality effects likely would be confined to only the wetland. Where wetlands were a result of large amounts of soil moisture and groundwater discharging to the surface in a concentrated area, the effluents could be carried off-site to contaminate surface water or groundwater elsewhere. Also, drill holes left unplugged upon abandonment could dry out wetlands by funneling soil moisture and surface water that drains into the wetland into the groundwater system.

Water supply, recharge and discharge could be affected in several ways. Sinking of air-vent shafts, mine shafts and building foundations could obstruct the flow of soil moisture or groundwater draining to wetlands and divert it elsewhere. On the other hand, these same activities, along with road building, might divert more water to wetlands than occurred naturally.

The extent to which groundwater lowering by mine dewatering might affect wetlands is difficult to assess. Most of the area's wetlands are a result of very local water tables perched on top of slowly permeable soil or rock strata, rather than being a result of the regional groundwater mass lying at the ground surface. Because of this, it is possible but not proven that mine dewatering might have very little effect on wetland hydrology.

Wetland contamination by fugitive heavy metals from a nearby mine/mill could be minimized to very low levels by careful industrial practice, but probably could not be prevented entirely unless the mine/mill and wetland were several miles apart. Slowly permeable wetlands with clayey soils and high organic-matter probably would retain most of the metals delivered to them; rapidly permeable wetlands might not. What the effects of low-level heavy-metal contamination on wetlands might be is unknown.

Because most of the study area's wetlands are less than five acres, they have little moderating effect on flood and storm hazards.

All mineral activities associated with soil disturbance have the potential to cause erosion and sedimentation. Wetlands with closed surface drainage could be filled to some extent by sedimentation, but would prevent the spread of sediment to other places. However, wetlands with flow-through surface drainage, on the other hand, could be eroded if excess water was diverted to them, and the eroded material would cause sedimentation elsewhere.

Although effects to wetlands could happen in the exploration scenario, they are more likely in the two development scenarios.

Maintenance of Natural Systems

Wetlands are an uncommon feature of the study area's landscape. As such, they are an important factor in overall habitat diversity, and some are known to harbor rare and unusual plant life unable to survive elsewhere. None are important for food or fiber production. Some support commercially valuable timber growth, others do not.

Although diverting water away from wetlands would obviously have effects on natural systems, the effects of diverting more water to them are less certain. A lot of extra water

might drown out some vegetative communities, and different communities might take their place. The drowned-out communities might, however, migrate to higher ground where moisture conditions were comparable to their former location.

All mineral activities causing soil or vegetative disturbance or hydrologic alteration could affect these wetland values. Effects could occur during exploration, but would be most likely during development.

Other Uses in the Public Interest

Because of their scarcity and unusual biological features, the study area's wetlands provide unique recreational, visual, scientific and nature-study opportunities. Their value as archeological and historical sites is unknown.

All mineral and mineral-related activities which alter the hydrology or disturb the soil or vegetation could affect these wetland qualities. Effects could happen just as easily during exploration as during development.

Mitigation Measures

The following mitigation measures have been identified for use with all wetlands within the study area.

Forest Plan standards protect water quality (pages IV-45 and 46), require compliance with EO 11990 (pages IV-46 and 72), require buffer zones around wetlands (page IV-47), protect against erosion, sedimentation and loss of soil productivity (pages IV-47 and 48), protect threatened, endangered and rare plants and animals (pages IV-52 and 53), protect riparian areas (pages IV-46, 53 and 54), and prohibit drilling within and next to wetlands (page IV-71). The Missouri Clean Water Act (Chapter 644) requires that all drill holes be plugged so that surface contaminants are excluded from groundwater. In addition, the National Historic Preservation Act of 1966 (36 CFR, Part 800), as amended, and Forest Plan standards (pages IV-30 and 31) for cultural resources, would protect archeological and historical values.

Design and locate facilities to reduce disturbance and facilitate reclamation. No surface occupancy of wetlands will be permitted. Field surveys will be done to determine if wetlands are present on proposed project sites.

Design and locate facilities to allow natural water flows.

Effects After Mitigation

Assuming all Forest Plan standards, and Federal and State laws and regulations, and mitigation measures were complied with, there would be little likelihood of wetland values being affected.

FLOODPLAINS

This section discusses effects which mineral activities might have on the study area's floodplain values which are defined by the U.S. Water Resources Council (1978) as the natural moderation of floods; water quality maintenance; areas of groundwater recharge; large and diverse populations of flora and fauna; sites of cultural resources (archeological, historical, recreational, visual beauty, scientific and nature-study areas, noise absorption areas, and areas where air is cleaned and cooled); agricultural production; aquacultural production; and forest production.

The possible effects of mineral activates are discussed for each of these values. Then, the Forest Plan standards, and local, state and federal laws, ordinances and regulations affecting mineral-related activities and floodplain values are discussed. Finally, likely effects on floodplain values are presented if all of the regulatory requirements were met. Possible effects to floodplains vary by scenario rather than alternative so this discussion will focus on level of mineral activity rather than alternative.

Natural Moderation of Floods

Floodplains provide areas where floodwaters can spread out and be temporarily detained for later discharge down-valley. This value could be affected by construction on, and reshaping of, the floodplain, which could force floodwaters to quickly rush downstream rather than being temporarily stored for gradual drainage later.

Exploration activates would not affect the natural operation of floodplains. The construction of mine/mill facilities or vent shafts could affect natural flows.

Water Quality Maintenance

The rich biological environments of many floodplains have the ability to purify tainted water draining through them. Significant removal of floodplain vegetation and suppression of the soil and humic microbiological community could alter the floodplain's water quality maintenance capability. Mineral related activities which could cause significant degradation to this floodplain value are those which permanently devegetate sizeable areas, reduce soil permeability, or chemically alter the soil and humus to the detriment of micro-organisms. Activities most likely to cause these effects include mine, mill and long-term-use road construction, and the contamination of soil and humus with heavy metals. However, tailings impoundments, on the other hand, could enhance this floodplain value by keeping heavy metals and other substances from reaching area waters, if the water tightness and no-discharge requirements were met.

There would be little chance that exploration activities could affect the floodplain's water quality protection capability. Significant effects are most possible in the low- and high-development scenarios.

Groundwater Recharge

Many of the study area's floodplains are major groundwater-recharge sites. Mineral activities which decreased floodplain permeability would degrade this value. The most likely causes for degradation would be mine- and mill-site construction.

Floodplain tailings impoundments present a paradox. On the one hand, the impoundment's hydrostatic head would tend to increase groundwater recharge through the pond bottom. Because of the pond's mill-effluent contents, however, groundwater would be degraded rather than benefited. Successfully sealing the pond from leakage, on the other hand, would protect groundwater quality but degrade the floodplain's recharge capability.

Flora and Fauna

Floodplains often have larger and more diverse plant and animal communities than surrounding uplands. Clearing and herbiciding vegetation for drill sites, roads, powerlines and possibly mines, mills, ponds and lagoons could affect floodplain communities.

Effects could occur in all scenarios. The most significant effects would occur if mines, mills, powerlines, tailings impoundments, mine dewatering ponds or major roads were built in floodplains.

Vegetation and wildlife habitat would be changed by drilling, roads, mines, mills, ponds and powerlines. Additional information is in the sections on vegetation and wildlife.

Cultural Resources

Executive Order 11988 takes a broad view of cultural resources, including not only archeological resources, but recreational, visual, scientific, educational, quietness and air purifying and cooling ones as well. Mineral activities could affect all of these resources in all three scenarios.

Archeological resources would not be at risk from mineral activities because pre-disturbance investigations would establish their presence or absence. If present, artifacts or information of value would be recovered before disturbance could begin.

Exploration activities could have temporary effects on dispersed recreation quality, visual beauty and quietness. Mining and milling could destroy all of these values on site, and degrade them in the nearby area.

Agricultural and Forest Production

Whatever significant aquacultural opportunities might have existed in the study area have been foregone by preservation of the Eleven Point River in its natural state. None exist elsewhere in the study area.

Drill sites, roads, mines, mills, tailings and minewater-clarification ponds, powerlines and substations, home and business sites, all would affect the study area's agricultural and forest production capability to some degree by removing some acres from production.

Agricultural and forest production on portions of study area floodplains could be temporarily disrupted by mineral activities which occurred there. The single greatest effect could be from tailings impoundments each of which could permanently inundate as much as 200 to 300 acres of floodplain land.

Mitigation Measures

Forest Plan standards require compliance with Executive Order 11988 which permits construction on, and reshaping of, floodplains only when no practical alternative exists (pages IV-46 and IV-72), and with Corps of Engineers' Section 404 Permits governing the placement of dredge and fill materials (page IV-46). Forest Plan standards also require the maintenance of soil productivity (page IV-47), the protection of riparian areas (pages IV-53 and IV-54), the minimizing of non-point pollution (page IV-45), streamside filter strips (pages IV-45 and IV-46), and protection of threatened, endangered and unusual plant and animal species habitats (pages IV-49-57). The Missouri Clean Water Act (Chapter 644) requires that all drill holes be plugged upon abandonment so that surface contaminants are excluded from groundwater.

Carter County is enrolled in the National Flood Insurance Program, and floodplain occupancy by the mineral industry would have to comply with county requirements for that program. In addition to Forest Plan standards and other laws and regulations, the following mitigation measures are proposed to protect floodplain values.

Design and locate facilities to reduce disturbance and facilitate reclamation. Permanent structures would only be permitted in floodplains if there were no other locations available and only after further analysis. Also, no activities would be permitted without site specific cultural resource clearance.

Design and locate facilities to allow natural water flows.

On site disposal of drilling effluents. Spread effluents and cuttings away from stream channels and surface drainages.

Effects After Mitigation

Assuming that Forest Plan standards, EO 11988, and Corps of Engineers' Section 404 permit requirements were complied with, the likelihood that floodplain water quality maintenance

capabilities or other floodplain values would be affected is quite small.

AIR QUALITY

Mineral-related activities that create dust and release exhaust gases or other fumes into the atmosphere may affect existing air quality within the study area. These activities include road and site clearing, vehicular traffic and mine/mill emissions. People have expressed concern that such activities would threaten or degrade scenic, recreational, natural and cultural resources of the area. A reduction in air quality within or adjacent to such areas could detract from the user's enjoyment.

Changes in air quality are dependent upon the proximity of emissions to sensitive environments and the volume of contaminants released into the atmosphere. Pollutants released within or immediately adjacent to sensitive, more pristine environments such as the Irish Wilderness, Eleven Point Scenic River and the Ozark Riverways would tend to have a greater effect than pollutants released at a distance from such areas. Similarly, the volume of emissions would directly affect the degree of change in existing air quality.

Alternative B could result in the greatest possible change to existing air quality in sensitive areas. Under this alternative, mineral related activities could be sited immediately adjacent to sensitive environments. Pollutants within or visible from such environments would diminish the user's experience. Through varying restrictions, Alternatives C, D, and E would reduce the potential for change in air quality. Under these alternatives, mineral-related activities could not be located in close proximity to the most sensitive environments, and pollutant sources should be further away. It is anticipated that minerals-related activities under Alternatives B, C, D, and E would be essentially the same and existing Federal air quality standards would be maintained

The principle factor affecting air quality is the volume of pollutant emissions. The level of mineral-related activities which occur within the study area would determine emission volume.

Exploratory drilling would introduce low levels of contaminants into the air. These contaminants would consist of engine exhaust fumes from vehicles and drilling rigs. Due to the scattered drill sites and the distribution of drilling over time, no significant adverse effects are anticipated.

The development of a mine/mill as identified in the low development scenario, would introduce increased industrial activity into the area. Drilling activity would also increase. Initially, during the mine/mill construction phase, there would be increased vehicle emissions. However, the level of emissions would not increase beyond Federal standards. Construction activities would undoubtedly increase the level of dust particularly during dry conditions. These levels would be expected to be periodic and would result in no significant violations of Federal standards.

Mine/mill operations would increase particulate matter (fugitive emissions) contributed to the environments from material stockpiles and transportation of ore. This particulate matter would be concentrated in the vicinity of the mine/mill along the transport routes and around the tailings impoundment. The greatest concentration would be at the mine/mill site.

Heavy metal particulates would consist primarily of lead and associated minerals such as zinc, copper and cadmium. Around the tailings impoundments the particulates would also include limestone.

Transportation of the processed lead ore concentrate (essentially lead sulfide) in uncovered trucks could result in the distribution of heavy metal particulates along highway corridors. A study of lead levels in the Viburnum Trend found increased levels along ore transport routes. Further, there were higher levels adjacent to rough highway surfaces, indicating increased particulate distribution due to rough roads (Wixson and Jennett, 1979).

The finely ground material in the tailings impoundment could be easily transported from the site by wind. This material would then be redeposited at varying distances from the source depending on particulate size and wind velocity.

The development of two or more mine/mill complexes as identified in the high development scenario would increase the level of particulate matter dispersed to the environment. The increased density of industrial activity would probably increase the likelihood of individuals encountering contaminants.

In both the low and high development scenarios, the contaminants would settle out in direct response to the size of the particulate; the turbidity of air movement; and the amount, timing, and duration of rainfall thus passing from the ambient air. This would occur in close proximity to the source.

Mitigation Measures

Mitigation provided by the Forest Plan standards include not approving any activity which does not conform with Missouri Air Quality Implementation Plan and project modification as necessary to protect and maintain air quality.

In addition to Forest Plan standards the following mitigation measure is proposed to reduce effects to air quality.

Minimize wind-blown contaminants. Pave mine/mill parking lots, storage yards and access ways. The periodic washing of paved areas and

the recovery/recycling of collected material would reduce the amount of particulate material dispersed to the environment. Transport ore or concentrates in covered trucks. Wet the tailings to reduce dust blowing off the impoundment.

Control point-source pollutants. Require filtering of all mine exhaust fumes before releasing them to the air.

Effects After Mitigation

Proper application of Forest Plan standards, as well as the mitigation measures should maintain the air quality within Federal Standards.

VISUAL RESOURCE

The public is concerned that mineral activities would change the visual quality of the study area. Seeing the rugged terrain, dense hardwood forests, numerous springs, rock outcrops and scenic rivers are very important to both residents and visitors. In part, the natural beauty of the landscape is why they are here.

Mineral activities could change the visual resource by changing the natural lines, form, texture or color of the landscape. The significance of the effect would vary by the distance and natural screening between the observer and the activity. The closer the opening is to the observer, the more pronounced the change in the landscape. Therefore, this discussion describes the potential change to the study area landscape as seen from the most frequently used recreation areas and travel routes.

The effects of mineral activities on the visual resource can be grouped into three general categories consisting of openings, corridors, and structures.

Openings

Drill sites, vent shaft clearings, mine/mill sites, dewatering ponds and tailings impoundments all create openings. They would range in size from 1/10 acre drill sites to impoundments of 250 acres or more.

Drill and vent sites, although small, could affect the natural landscape because their regular shape would be a departure from the natural forms common to the area. Also, they would create a vertical forest edge which is an unnatural line in the landscape.

Mine/mill sites might significantly impact the landscape. These openings (30 acres or more) are usually flat and would contrast dramatically with rolling topography. They would also create a vertical line that contrasts with the surrounding area. Further, the vegetative regrowth (shrubs, forbs and grasses) would vary from the adjacent vegetation in texture and color. Parking lots and roads would also be an obvious change from the natural colors and textures of the landscape.

Mine dewatering ponds would change the line and texture of the landscape. The sharp edge of the clearing against the forest would be abrupt. Unlike tailings ponds, dewatering ponds are usually not visually obtrusive. They are small, natural appearing and can actually serve to enhance the landscape by providing pleasant visual variety.

Tailings impoundments would create the largest openings (200-300 acres) and have the potential of creating the greatest impact on the visual resource. Often the impoundments are constructed by damming a hollow and filling it with water and tailings. The impoundment is usually surrounded by dead trees whose roots are beneath the water, but whose tops are above the water line. This dramatically changes the color and texture of the landscape. Exposed tailings and the earthen dam further aggravate the change of color and texture. The natural line is changed by the abrupt forested edge adjacent to the impoundment. Further, the large flat water and tailings surface is significantly different from surrounding rolling hills.

Mitigation Measures

A Landscape Management Plan consistent with the Forest Plan standards, prepared before development occurs, should include the following measures:

Design and locate facilities to reduce disturbance and facilitate reclamation. Reduce the departure from natural line and form by varying the opening borders to take advantage of terrain features. Create irregular shapes along contour line rather than straight lines across the contour. Use plants of varying heights to grade from grass to forbs to shrubs to trees to minimize departure from natural line and texture.

Reclamation plans will include provisions for immediate stabilization and meeting Forest Plan objectives. To minimize impact on color and texture, properly selected species of grass, forbs, shrubs, and trees will be sowed/planted on sites disturbed by impoundment construction, mine/mill sites, vent sites and drill sites. In addition, trees will be removed from within the planned tailings impoundment area to reduce the departure from natural color and texture.

Effects After Mitigation

Essential to successful mitigation of impacts is timely landscape planning. Revegetation of disturbed areas, shaping of openings, and transition of vegetative canopy at opening margins would be effective in reducing the impacts of departure from natural form, line, color and texture.

Corridors

Transmission line rights-of-way, pipelines and roads all create corridors. These corridors would affect the line, color, form and texture of the landscape differently than openings.

Transmission lines would create an abrupt change or "wall" at the edge of the cleared area. There would also be differences in vegetation height, color and texture (low shrubs, forbs and grasses) from the surrounding landscape. This would affect the texture and color of the seen area. Depending upon the terrain, the visual change might be noticed for several miles and would often appear as a wide swath on a distant slope.

Pipelines are similar to transmission lines except that they would be narrower and usually not as long. They could often be snaked through a valley rather than across ridges, which would make them less obvious to forest users.

Roadways are obvious because they are flat with cuts and fills. Further, roads are devoid of vegetation so they have a very obvious effect on the natural texture and color.

All corridors create the straight line "alley" effect. There is a sharp line between the clearing and the woods.

Mitigation Measures

As with openings, a prescribed Landscape Management Plan consistent with Forest Plan standards should be prepared before mineral activities begin. Such a management plan should include:

Design and locate facilities to reduce disturbance and facilitate reclamation. To reduce departure from natural texture and line, plan right-of-way clearing to take advantage of contour features instead of regular, straight configuration.

Manipulate vegetation (revegetated/natural) so that plants are graded from grass to forbs to shrubs to trees along corridor edge to reduce departure from natural texture and line.

Plan road and trail crossings so that right-of-way is least visible by crossing travelways at right angles.

To minimize disruption of the landscape, bury powerlines in the most visually sensitive areas (especially foreground along level 1 and level 2 travel routes.

Reclamation plans will include provisions for immediate stabilization and meeting Forest Plan objectives. Sowing/planting of properly selected species should be done at the earliest opportunity to minimize impacts of right-of-way clearing.

Effects After Mitigation

Revegetation and shaping of openings, transition of vegetative canopy, and reduction of the "alley" effect would be effective in reducing impacts of departure from the natural form, line, texture and color.

Because current technology would not permit cost-efficient handling of the conductors, burying major powerlines would probably not be feasible.

Structures

Mining requires construction of some facilities. There would be mine/mill structures, transmission line supports, and dams. Each of these would be an unnatural object in the visual environment.

Mine/mill structures would significantly depart from the naturalness of the landscape. These large one to two story buildings of stone, steel or brick would stand out in the middle of clearings. Their visibility would depend upon the height of the surrounding vegetation and their position on the slope; but they are definitely not natural appearing and they would be difficult to hide.

Headframes and transmission line supports would be up to 100 feet high. They have strong vertical lines and angular braces. The hard steel would stand out against the soft texture of the surrounding woods. Their color would also stand out from the landscape.

Dams would noticeably change the visual character of an area with their horizontal intrusion (line) to what had been a valley landscape. Because it would be made from tailings, impoundment dams would also be different from the surrounding landscape in color and texture. When viewing such a dam from below or from in front, viewers would experience a significant change in the landscape.

With the exception of Alternative A, the same number of acres would be affected by each alternative, depending on scenario. The difference between alternatives is the location and noticeability of the activities.

Mitigation Measures

As in the case of openings and corridors, a prescribed Landscape Management Plan consistent with Forest Plan standards should include:

Design and locate facilities to reduce disturbance and facilitate reclamation. Utilize colors to blend with or complement natural surroundings (paint or otherwise color such items as powerline supports, conductors and building materials).

Use natural materials (wood, stone) where possible to complement surroundings.

When possible, locate facilities behind natural screens such as ridges or tall vegetation to screen structures from sensitive travelways.

Effects After Mitigation

Although they would still be visible from some areas, screening and use of natural materials or complementing colors would reduce the visual impact of structures.

Alternative B would permit mineral activities to occur anywhere in the study area except the Eleven Point River corridor. The impact of these activities on the visual resource would depend upon their proximity to the major recreation areas and travel routes. However, this alternative does nothing to prevent these activities from occurring immediately adjacent to visually sensitive areas. Therefore, the risk of significant impacts to visual resource is high. If mine/mill sites, tailings impoundments, haul roads, transmission corridors or pipelines were permitted within the seen distance of these sensitive areas, the visual quality would be greatly reduced.

Alternative C would prohibit all mineral activities, except drill sites, from occurring within the seen area of the major recreation areas and travel routes. This would greatly reduce the risk of these activities affecting the visual resource. Mineral activities would be permitted in the northern and eastern portions of the study area, and would affect the visual quality of this part of the study area.

Alternative D would not be less restrictive than Alternative C, but more restrictive than Alternative B. It might be possible to see the edge of transmission corridors and tailing impoundment clearings from recreation areas and travel routes. However, these activities would be sufficiently far away that they would not dominate the landscape. Drill sites, mine/mill sites, pipelines and dewatering ponds would probably not be visible from major use areas.

Alternative E would be less restrictive than Alternative D and conceivably would permit more roading and development.

CULTURAL RESOURCES

Earth-disturbing mining activities could affect cultural resource sites. People are concerned that mining activities might threaten or destroy archeologic sites and resources.

Although cultural resources are protected by various laws and directives, including the National Historic Preservation Act and the Forest Plan, it is probable that impacts would occur on cultural resource sites.

The potential for disturbance would vary considerably between the exploration and development scenarios, and to a certain extent between alternatives.

During exploration activities, sites encountered could be avoided by locating roads or drill sites on less sensitive locations nearby. It is conceivable, however, that a large cultural site could not be avoided and would require further evaluation with eventual mitigation necessary if the property were found to be eligible for the National Register of Historic Places.

Effects to cultural resources would be more likely in the low development scenario and most likely in the high development scenario. The larger areas of disturbance needed for mill sites, haul roads, powerlines, and especially tailings impoundments (200-300 acres) would offer a much greater chance of conflict with archeologic sites (the average site density on the forest is one site per 100 acres).

Also, chances of impact would be increased because of the likelihood of operators needing to occupy such as bottomlands and flat ridgetops with a high probability of archeological sites.

Alternative B would offer the highest probability of site encounters since development could occur throughout most of the study area, especially in the vicinity of live streamcourses. Flat ridgetops are prime areas for historic home places and virtually every ridge is roaded, so the likelihood of historic sites is great.

Alternative C would offer the lowest probability for prehistoric site encounters since most of the area allowed for development is away from streamcourses. The probability of encountering historic sites would probably be similar to that of Alternative B.

Alternative D would not offer a great deal more opportunity for prehistoric site encounters since development would still be precluded in much of the streamcourse area. Historic site encounters, however, would probably exceed that of Alternative C since more area would be available for development in ridgetop locations.

Alternative E would offer opportunities similar to Alternative D, except that the probability of encountering prehistoric sites.

Mitigation Measures

Mitigation measures consistent with the Forest Plan include:

Design and locate facilities to reduce disturbance and facilitate reclamation. All sites involving earth disturbance must be surveyed prior to activity. If a cultural resource site is encountered, the activity should be relocated to a suitable location or the cultural materials should be collected.

Effects After Mitigation

Surveying all proposed project locations would almost eliminate the chance of disturbing unknown cultural resource sites. Avoiding those sites encountered would prevent all disturbance to them.

AREAS OF NATIONAL SIGNIFICANCE

Within and in the vicinity of the study area are a number of nationally significant sites that have been recognized for their unique character. These sites are managed under specific guidelines to protect and retain their unique qualities. The public has raised the issue of the potential effects on areas of

national significance areas from mineral activities. Areas of national significance include the Eleven Point National Scenic River, Greer Spring, Ozark National Scenic Riverways, Irish Wilderness and Cupola Pond.

Eleven Point National Scenic River

The Eleven Point River is within and adjacent to the study area. Potential visual impacts to this area are addressed in the visual resource discussion in this Chapter. Possible impacts to the areas recreation use are addressed in the recreation discussion in this Chapter.

Mitigation Measures

Design and locate facilities to reduce disturbance and facilitate reclamation. Mineral activates with the exception of exploration, will not be permitted within the Eleven Point National Scenic River zone.

Effects After Mitigation

The National Scenic River values will be protected.

Greer Spring

Greer Spring is located on private land within the study area. Even though it is on private land, management of nearby National Forest System lands could affect this special feature. The water resource discussion in this Chapter addresses potential impacts to springs.

Cupola Pond

Cupola Pond is included in a 160 acre area designated as a National Natural Landmark. As such, it is recognized in the Forest Plan as a "Special Area" and is afforded the same protection/enhancement consideration as other special areas.

Activates analysed in this document would not physically affect Cupola Pond with the possible exception of impacts to groundwater. Those potential impacts are addressed in the water resources discussion of this Chapter.

Irish Wilderness

The Irish Wilderness is located adjacent to the southeast corner of the study area. Mineral activities are prohibited within the Wilderness. However, nearby activities may indirectly affect the area. Such activates would not effect the physical environment of the Wilderness itself, but could affect area users. These impacts would include changes in noise or aesthetics, interaction with mining personnel or equipment, and changes in wilderness use.

Sounds from nearby exploration and development could be heard by wilderness users who expect to hear only the sounds of nature. Man-caused sounds could reduce the quality of the wilderness experience for these users.

No visually disrupting activities are permitted in the Wilderness, but visitors along the northern end or at vantage points within the Wilderness might see mineral facilities, structures, or activities. Some wilderness users might perceive these sights as incompatible with their expectations of what wilderness is.

Interaction with mining personnel and equipment would not directly impact the wilderness user, since there would be no roads or development in the Wilderness. Indirect impact, however, would be a likelihood should development, especially under the high development scenario, occur near J Highway or other travel routes leading to the Wilderness.

Wilderness recreation use, as we know it today, could change substantially in numbers and clientele if unmitigated high development were to occur adjacent to the Wilderness. The most likely change would be in numbers and clientele as people desiring more solitude would seek areas of less disturbance.

In Alternatives C, D, and E, it would be very difficult to develop the area just north of the Irish Wilderness. The area north of the town of Wilderness and south of Sinking Creek Lookout Tower is bounded by sensitive travel routes. As such, visually impacting activities like transmission corridors, tailings impoundments, and mill sites are prohibited in much of that area.

Mitigation Measures

Forest Plan standards which protect areas of national significance and their unique values are included in pages IV-139, 154-163, 201-205 and 206-207. Other measures to minimize effects and reduce changes resulting from mining activity would include:

Design and locate facilities to reduce disturbance and facilitate reclamation. Measures taken to reduce effects of visual disturbance would be the same as those discussed in the Visual Resources section.

Sensitive planning and location of facilities to minimize interaction of those using primary access routes or adjacent areas would help mitigate impacts. Considerations would be very similar to mitigation of Visual Impacts.

Use noise abatement techniques and practices. Muffling devices and/or other sound absorption measures would reduce the likelihood that mineral related sounds could be heard by wilderness users. This would maintain the quality of the wilderness experience.

Effects After Mitigation

Mitigation of noise impacts adjacent to the Irish Wilderness could be accomplished with sensitive planning to keep noise at the current level. Visual impacts would have no direct effect on wilderness users if adequate landscape planning occurred.

Interaction with increased numbers of people and vehicles along access routes would be the most difficult to mitigate. Increased interaction would be very likely if development or mining traffic were to occur within the J Highway area.

Ozark National Scenic Riverways

The Riverways is 8-1/2 miles distant from the study area at the closest point and in all likelihood would be 15 to 20 miles from potential development. Impacts from mining activity would therefore be indirect and probably confined to "Interaction with Mining Personnel and Equipment" and "Recreation Use Changes."

Interaction would most likely be with truck traffic, hauling concentrate on Highway 60, if the product was transported through Van Buren. Currently, large truck traffic is present on Highway 60, a major artery across southern Missouri. Some noticeable increase in traffic would be likely under the High Development scenario. Even so, it is unlikely the increased interaction between recreationists and mining traffic would be a significant problem.

Another potential impact on the Riverways is change in either numbers or types of Recreation Use.

The number of Ozark National Scenic River users has been fairly steady for the past 5 years. In 1985 on-river use numbered 375,000 people. It is surmised that Riverways use has arrived at its use capacity (David Foster, NPS Research Biologist). An increase in users, especially users of motorcraft, could significantly impact Riverways management. Projections estimate in-migration of 570 workers under the high development scenario. In all likelihood, some new residents would use the Riverways, many with boats and motors rather than canoes. Increased motorboat use would be more critical and might require revising rules or directions to adequately accommodate impacts, maintain user experience levels, and protect river natural resources.

Opportunities now exist for a wide variety of users within the Ozark National Scenic Riverways. A large portion of the river is available to motor boat users and large parties. There are also opportunities for the "high-solitude" users, especially during low use days and light use season. High development activity could conceivably influence the high solitude seeker to find other recreation opportunities as more people use the river. It is thought, however, that this negative influence would be minimal.

Mitigation Measures

Improved recreation opportunity awareness. Communication or marketing of other recreation opportunities, including Forest Service facilities on other parts of the Forest, Corps of Engineers facilities and State recreation opportunities.

Effects After Mitigation

Mitigation measures to treat impacts on the Ozark National Scenic Riverways could minimize effects of conflicting use and overcrowding. Probably the most acceptable and effective measure would be to advertise recreation opportunities which are available elsewhere.

SPECIAL AREAS

The public raised the issue that mining activity might potentially affect some of these unique or special areas.

Direct mineral activity would not be permitted in the geologically Special Areas except the Irish Wilderness Excluded Lands. However, these areas could be directly affected by changes in water quality or quantity due to mineral activities. Potential effects are addressed in the discussion of Water Resources.

Indirect effects such as noise, esthetics, or interaction with mining people/equipment would be the same as those discussed in the Recreation and Visual Resources sections.

Mitigation Measures

Special Area values would be protected by applying Forest Plan standards on pages IV-194 thru 280 to minimize potential impacts to these resources. In addition, mitigation measures prescribed to protect water, recreation and visual resources would reduce indirect impacts to the special areas.

Design and locate facilities to reduce disturbance and facilitate reclamation. No surface disturbing activities will be permitted in the special areas except the Excluded Lands. This will protect the unique values for which the areas are recognized.

Sensitive planning the in the Excluded Lands could effectively reduce the visual and noise impacts.

Effects After Mitigation

Special area values and uses will be protected by applying Forest Plan standards and mitigating measures.

RECREATION

Forest recreation users have a special interest in the scenic quality and water resources within the study area. They are concerned about the potential effects to these resources which could result from mineral-related activates. In addition, people have expressed concerns regarding possible effects to recreational enjoyment as a result of increased traffic and noise, and the presence of industrial facilities.

This section discusses the effects resulting from mineral activities as they relate to recreation experiences, including increased noise, changes in aesthetics and wildlife

sightings, interaction with mining personnel and equipment, and changes in recreational use.

Construction activities and drilling operations at exploratory drill sites would create noise. Considerable noise could also be generated by equipment, trucks and machinery in the vicinity of mine/mill complexes, and vent fans. All these man-caused noises could reduce the enjoyment recreationists get from experiencing the natural environment.

Impacts on the visual resource are a concern to forest users. Landscape openings, corridors and structures, industrial equipment, large trucks and administrative vehicles would all be apparent to users, particularly under the high development scenario. The quality of the experience could be reduced if recreationists perceive these activities as being unnatural or unwanted. The effects to esthetics are discussed in the Visual Resource section in this Chapter.

Occasional sighting of animals can be very important to the recreation experience. Increased noise and activity could result in a change in wildlife sightings within the study area.

Movement of mining related equipment and personnel would be obvious to forest users. Interaction may be occasional and no more noticeable than other business traffic (e.g. logging and farming), but if mining activity were intense and concentrated, it could significantly affect the user's experience.

Potential changes to existing recreational use volume, use-patterns, opportunities and clientele resulting from mineral activities is a concern expressed by many people. There may be little or no appreciable changes during exploration activities or low development in non-sensitive areas. Recreation use could change considerably however, if intensive mining activities were conducted in highly sensitive areas.

This discussion describes the potential effects by scenario first, then describes the effects between the various alternatives.

Noise

Noise during mineral exploration would be greatest during construction of drill sites and access roads. Drilling operations would generate less noise, but the actual impact depends on the proximity of the operation to recreation users. Unmitigated exploration activities under any alternative except A could be very disruptive. For example, drilling operations on a Saturday in the Eleven Point River corridor or in the vicinity of a campground would result in a high level of noise that would be obvious and intrusive to recreationists.

Noise during low and high development scenarios would be similar. However, concentrated operations would be likely to affect more forest users. Noise from mine/mill operations might be evident, but noise from equipment at mine/mill sites and on haul roads would be more intrusive. Further, noise from vent shaft fans can be heard for up to two miles from a vent site.

Alternative B would permit mine/mill sites throughout the study area except within the Eleven Point River corridor. The most significant effect to the recreation user would be noise from activities located in the southern half of the study area in the vicinity of developed recreation areas (McCormack Lake, Falling Spring, Greer), trails (Ozark and Blue Ridge), the Eleven Point River and the Irish Wilderness.

Alternative C would limit mineral activates to the low sensitivity areas comprising approximately 30% of the study area along the northern and eastern edges. Such a restriction would essentially prohibit activities in the most important recreation areas, with the exception of an area just north of the Irish Wilderness.

Alternatives D and E would permit mine/mill development in basically the northern half (except in the foreground of sensitive travel routes) of the study area. The greatest potential for conflict would result from unmitigated vent shaft noise). Alternative E would permit additional roading and development just north and south of the trail corridors and in the Spring Creek Area.

Mitigation Measures

All mineral activities would have to comply with Forest Plan Recreation Opportunity Spectrum standards (page IV-27). Measures available to minimize effects of noise on recreation experiences include:

Design and locate facilities to reduce disturbance and facilitate reclamation. Limit drill site and access road construction and drilling activities to low recreation use periods - late fall to early spring, weekdays. Limit development to locations distant from highly sensitive recreation areas.

Use noise abatement techniques and practices. Provide for sound absorption or diversion on tools, equipment, and vehicles. Place fan motors underground, muffle or absorb sound.

Effects After Mitigation

Noise can be minimized but not eliminated. The most effective mitigation would be to locate development in the lower sensitivity areas (northern half of study area) since unmitigated noise violates a Recreation Opportunity Spectrum (ROS) guideline (Solitude) for high quality recreation areas.

Wildlife Sightings

Exploration activities would not significantly change the number or kind of wildlife sight-

ings. The operation of machinery might actually attract curious wildlife, enhancing sighting opportunities. Impacts on wildlife sighting opportunities are anticipated to be imperceptible under all alternatives.

Development and operation would not significantly affect the opportunity for wildlife sighting. The most critical potential impact would be on river or riparian habitat which is limited and confined more than other habitats. No problem with animal populations or sighting opportunities would be anticipated throughout the study area.

Mitigation Measures

All mitigation measures described in the wildlife section of Chapter 4 would reduce the impact on wildlife habitat and populations, maintaining opportunities for wildlife sighting. Measures to be taken to minimize impacts on wildlife sightings include:

Design and locate facilities to reduce disturbance and facilitate reclamation. Limit exploration or development in the vicinity of river and riparian habitat to non-nesting seasons.

Effects After Mitigation

Disturbance to nesting birds would be reduced and help insure that nesting birds would stay in the area and/or return in future years.

Interaction

An increase in vehicular traffic caused by exploration activates would result in interaction between mining "agents," and other users; but it is not likely that the impact would be significant or particularly objectionable. The development of one mine complex (low development) in the vicinity of a developed recreation area, or its approach, would cause more interaction with recreationists. One located far from such an area, would primarily affect dispersed recreation users (fewer people congregated in one spot).

Regulations for the Eleven Point River prohibit development within its corridor. Therefore, no direct interaction would occur, although interaction could occur along river access routes. Interactions could similarly affect user experience along access routes to the Irish Wilderness. Interaction resulting from high development would be significantly greater due to the eight-fold increase in activity. Regardless of alternative selected, there would be some noticeable change in traffic along Highways 19 and J, even at a distance from sensitive recreation areas.

Alternative B would likely result in the most interaction since development could occur throughout the study area, except within the Eleven Point River corridor. The greatest potential for undesirable effects would probably occur in the vicinity of the river and the Irish Wilderness. Traffic volumes could increase along the northern boundary and northeast corner of the Wilderness. Alternative C, which would limit development to about 30% of the study area located along the northern and eastern edge, would result in less interaction near the more popular and sensitive recreation areas. Alternatives D and E would permit development over more of the study area, but still avoid the majority of sensitive recreation areas. The greatest potential for impacts due to increased traffic is anticipated to be in the vicinity of the Irish Wilderness.

Mitigation Measures

All mineral activities would have to comply with Forest Plan Recreation Opportunity Spectrum standards (page IV-27). Measures available to minimize effects of interaction with others include:

Design and locate facilities to reduce disturbance and facilitate reclamation. Limit construction and drilling activity to low use periods - late fall to early spring, weekdays.

Develop Only in Low Sensitivity Areas. Limit proximity of development to locations distant from highly sensitive recreation areas.

Effects After Mitigation

Impacts on the recreation user would be minimal during exploration. Impacts of interaction during development, particularly high development, would be difficult to mitigate if they occur near highly sensitive recreation areas.

The most effective measure to reduce conflicts would be to locate development in the lower sensitivity areas.

Changes In Recreation Use

Exploration is not likely to cause changes in the number of kind of recreation users in the study area.

Development could cause changes in the number or kind of recreationists, if those currently using the area considered mineral activities incompatible with their expectations or enjoyment. As more mineral activities occurred, there would be a greater chance that users would seek other areas more compatible with their recreation desires. The net change in numbers would, however, probably be small because the loss of high solitude seekers might be offset by increased use by in-migrating residents and other users.

Users of the Eleven Point River and Irish Wilderness are more likely to value solitude and, consequently, more likely to be disturbed by interaction or evidence of mineral activities. The greatest potential for use changes, therefore, would be a shift in the type of clientele attracted to these areas. People requiring a high degree of solitude and little interaction with other uses would be

likely to go somewhere else to find the experience they value.

Another potential cause for significant change in user number or type of user would be locating mining facilities near popular developed recreation areas. Most people use these areas because they provide some facilities, but are also natural appearing and relatively peaceful. Activities which intrude upon that peacefulness (such as noise from drilling operations or vent shafts) detract from the natural appearance, or remind people of the work week or might annoy some people so much that they would quit using a particular area or areas.

Alternative B would permit mineral activities throughout the study area except in the Eleven Point River corridor. Although impacts on recreation use could occur anywhere, they would be greatest in sensitive areas. Effects would increase with higher intensity activities occurring under the high development scenario. The most significantly affected recreation opportunities would occur within the Irish Wilderness. In Alternative C activities would be limited to 30% of the study area along the northern and eastern edges. Some development activity would be permitted in the vicinity of the Irish Wilderness. Development would otherwise be precluded from areas adjacent to sensitive recreation areas. Under Alternative D, development could occur adjacent to the Irish Wilderness. Alternative E would conceivably permit roading and development on the northern and southern margins of the trail corridors and in the vicinity of Spring Creek. Development under all alternatives would likely cause the greatest change in the Irish Wilderness, since users demanding a high degree of solitude would avoid the northwestern portion of the Wilderness.

Mitigation Measures

Mitigation measures to minimize changes in recreation use would be the same as those identified to mitigate effects caused by noise and interaction. Further, measures discussed with respect to visual resources, special areas and areas of national significance would also reduce effects to recreation use.

Effects After Mitigation

These mitigation measures would reduce the frequency and magnitude of conflicts between recreationists and mineral activities, but would not eliminate them.

BIOLOGICAL ENVIRONMENT

VEGETATION

Plants of Special Concern

Federal and State listed plant species could be affected by mineral activities in two ways. Habitat changes through clearing of sites could affect populations, and exposure to heavy metals, reagents, or other mine/mill wastes could affect individual plants.

The potential for these effects to occur is lowest under exploration and highest under the high development scenario. However, if effects occurred, there would be little difference between scenarios.

Of the thirteen listed plants known to occur in the study area, ten are found in wet, low habitats, two are glade species, and one is found on north- or east-facing slopes. Any surface occupying mineral activity has the potential to be located on these habitats. However, both glades and low, wet areas are uncommon in the study area and it would be easy to avoid siting mineral activities or facilities on these habitats under any scenario or alternative.

Plants may come in contact with heavy metals or other mill wastes through the soil or air. Wind-blown dust from mine/mill sites, tailings impoundments, or uncovered haul tracks could coat plants near those sites. Wind-blown dust may also settle on soil, where it becomes available for plant uptake. Heavy metals and other wastes which escape from tailings impoundments or mine/mill sites could wash into the soil and be available for plants to absorb through their roots. Plants of concern would mainly be affected if mineral facilities were located near their habitat.

An accidental release of tailings into the groundwater system could potentially affect plants of concern. Once the tailings were in groundwater, they could be passed into the wetland habitats of several of these species. Any heavy metals or reagents still present in the tailings would be available to the plants.

The potential effects of a release of heavy metals and milling reagents on listed plant species are unknown. However, laboratory experiments with other plant species have shown lead, zinc, copper and cadmium are all toxic to some crop plants at varying levels (McKee and Wolf, 1963). Delayed germination and slower growth rates have been documented for cress and mustard seeds due to elevated levels of lead, zinc, or copper (McKee and Wolf, 1963). Copper has also caused a decrease in the length of the main-stem root of tomatoes (McKee and Wolf, 1963). If plants of concern in the study area reacted the same way, individual plants might be affected. Shorter roots would reduce the plant's ability to absorb water and nutrients, thereby reducing its ability to survive. Delayed germination or slower growth rates might reduce the plant's ability to reproduce at the optimum time. Any of these changes might eventually reduce populations of these plants in the study area.

Mitigation Measures

Forest Plan standards require that Federal or State listed species be protected from disturbance (page IV-49, 50), provide guidelines for protection of special habitats (pages IV-51-58), and require compliance with Executive Orders 11988 and 11990 (pages IV-46). Measures which would reduce the probability of mineral activities affecting plants of concern include:

Design and locate facilities to reduce disturbance and facilitate reclamation. No surface occupancy of areas where there are known populations of plants of concern. A field survey of all proposed project sites will be carried out by biologists trained in recognition of listed plant species prior to initiation of any work. Surveys must be carried out during the appropriate season to increase reliability.

Minimize Wind-blown Contaminants. Cover trucks hauling ore, pave and wash down mine/mill sites, and stabilize tailings disposal areas. (the chance that wind-blown contaminants would be available to plants of concern would be reduced).

Tailings disposal must meet the State's "no discharge" requirement.

Effects After Mitigation

Prohibition of any mineral facilities on sites where there are known listed plants would eliminate the possibility of destruction of these populations. Surveys would reduce the chance that mineral activities would alter or destroy existing, but currently unknown, populations of plants of concern. The possibility that heavy metals, reagents, or other mill wastes would become available to these plant species would be reduced.

If they occurred, effects would be the same under any alternative. However, the potential for mineral activities to occur on or near listed species habitats is different under each alternative. Alternative B has the greatest potential to affect listed species, since mineral activates could be located anywhere in the study area. There would be no effect on listed species under Alternative A since there would be no mineral activities. Under Alternative C, all listed plant species are located within the visually distinctive part of the study area, in which powerlines and tailings ponds would be prohibited. Therefore, the potential for mineral activities to be located on or near listed species habitat would be very low. Alternatives D and E would provide protection of those species along the Eleven Point River corridor by prohibiting some activities within a certain distance of sensitive travelways. There would still be a chance that mineral activities would be located near some listed plants under these two alternatives.

WILDLIFE

Many people are concerned that mineral activities would change or destroy wildlife habitat and decrease animal populations. Of particular concern is the presence of Federal and state listed threatened and endangered species, species unique to the area and those sensitive to disturbance. This issue is closely related to the water resource issue, because almost all animals use water for various purposes, including shelter, feeding, and breeding.

A concern specifically identified by cooperating agencies and other interested individuals was the effect of mineral activities on caves and cave communities. Because caves have different physical characteristics from surface habitats, they are more sensitive to habitat changes. Cave creatures react to changes quickly but may be slow to recover.

All wildlife components such as terrestrial, aquatic, cave, and threatened and endangered can be affected in basically three ways: habitat change, population change, and a change in the biological integrity of the community of which they are a part.

Introduction (Terrestial)

Effects of mineral activities on habitats, populations and biological integrity will be discussed separately. Mitigating measures will be presented after each discussion and a comparison of alternatives will follow. Both Federal and State listed endangered, threatened, rare, and sensitive species are included in the discussion, since effects on them would be similar to effects on other terrestrial wildlife.

Habitat Change (Terrestial)

Access roads, vent shafts, drill sites, powerlines, and mine/mill site construction would change up to 181 acres of habitat under low development or up to 1175 acres under high development, by clearing vegetation from those sites. This would also destroy some nests, dens, and vegetative cover for various mammals, birds, reptiles, amphibians, and invertebrates. However, during reclamation of these sites, the straw used in mulching revegetated areas would attract small mammals and repopulation should be rapid.

The 30 acre mine/mill site, when completed, would be unsuitable habitat for most species. However, mice, rats, opossums, raccoons, owls, snakes, and possibly other animals might use the mine site at night when searching for food and could find spots to take cover during the day. Access roads, vent shafts and drill sites would provide edge habitat, small islands of open habitat in generally forested areas and travelways for many species. The powerline corridor would provide open habitat through mostly forests land. Lines and poles would provide perches for raptors and songbirds while

woodpeckers would feed on insects in and around the poles.

Should a tailings pond be constructed, approximately 200-300 acres of existing habitat would be altered or destroyed for some species, since the previous habitat would be under water or tailings. While in use, the tailings impoundment would be unsuitable as habitat for most wildlife species because of the hot, dry conditions created. Dead trees created by the impoundment could be used for perches, nesting or resting by birds, reptiles, or amphibians. After reclamation, the impoundment could provide a grassy area which would be suitable habitat for open land species such as doves, red-winged hawks, and woodchucks.

The 451 total cleared acres under low development would be less than 0.5% of the study area. A total of 3335 acres of cleared sites under high development would be 3% of the study area. Some of the cleared sites would be short term (drill sites, some access roads) while some would be used for long periods of time (up to 15 years for mine/mill site or in perpetuity for tailings disposal site).

No drilling, mine/mill, or any associated facility would be allowed on threatened and endangered species habitat or over known caves. Clearing of these sites could inadvertently destroy nest trees or potential nest trees of Cooper's or sharp-shinned hawks, grouse drumming logs, wood frog habitat and other potential breeding/nesting habitats or cover. If black bear were in the general vicinity of the construction, they would likely avoid the area to the extent possible. Individual bears might, however, frequent a construction site if garbage were not disposed of properly.

The Biological Assessment prepared in conjunction with this analysis (Appendix 9) concluded that mineral development activities "may affect" potential cougar habitat and wintering populations or potential nesting habitat for bald eagles (Federal listed endangered) due to the increase in access and activity and the unknown effects of an accidental release of effluents into areas waters.

Mitigation Measures

Forest Plan standards designed to protect wildlife habitat, including threatened and endangered species, can be found on pages IV-47, 49-58, 66, 71-73, 85, and 204 of the Forest Plan. These standards establish buffer zones for wetlands, seeps, springs, riparian areas, and other permanent waters and specify what activities are prohibited within those zones. They provide for relocation or alteration of projects which conflict with special habitats and protect threatened and endangered species habitat. Selective maintenance of all powerline corridors of 40 feet or greater is mandated to ensure habitat quality. Rehabilitation of drill sites and roads is specified. Restrictions on activities within the Eleven Point National Scenic River corridor are also provided.

Water quality is considered in the Plan on pages IV-72 and 82. Minimum requirements are established for settling ponds, sewage treatment facilities and water storage or transmission structures; and restrictions on sand and gravel production are established.

As applied to mineral activities, these measures would protect sensitive habitats from physical disturbance and would insure that those habitats which were changed by construction or clearing were maintained in the highest quality possible.

In addition to Forest Plan standards, the following measures have been identified to reduce habitat change.

Design and locate facilities to reduce disturbance and facilitate reclamation. Develop a management plan for all powerlines. Such a measure is required by the Forest Plan standards, pages IV-66 through IV-69 which specifies the quality of open habitat to be maintained, with a variety of plant species to provide food, shelter and niches for several animal species.

A field survey of all proposed project sites to determine the presence or absence of all threatened, endangered, rare, or sensitive species will be carried out by biologists trained in recognition of listed species prior to initiation of any work. Surveys must be conducted in appropriate seasons to increase reliability.

There will be no surface occupancy within threatened, endangered, rare or sensitive plant or animal habitats; wetlands; and buffer zones associated with riparian areas, springs, seeps and fens. No activities will be permitted in these buffer zones.

Reclamation plans will include provisions for immediate stabilization and meeting Forest Plan objectives. Revegetate all cleared areas with native plant species suited to that site. Sites may be seeded with herbaceous vegetation to provide an open habitat, or may be planted with tree species. Rehabilitation of tailings impoundments could be considerably more difficult than reclamation of other sites. The harsh environment provided by the tailings is not conducive to establishment of vegetation; although methods are being tried on existing impoundments and piles in the Old Lead Belt and Viburnum Trend, with some success.

Minimize wind-blown contaminants. Pave mine/mill sites and periodically wash the area down to collect heavy metals and other substances before they can escape off-site.

Effects After Mitigation

Although paving sites would cause a greater area to be unsuitable habitat for most species, it would reduce the chance of pollutants

entering adjacent soil, vegetation, or water and would contribute toward maintenance of quality habitat outside of the mine/mill site. Revegetation with native plant species would ensure suitability of sites as habitat when mine operations cease. Powerline habitat quality would be higher than under a powerline maintained by traditional methods. Surveys would reduce the chance that unknown habitats of listed species would be changed or destroyed by mineral activity. Populations of listed species would not be destroyed by locating facilities on known habitat.

Population Change (Terrestial)

Habitat change through destruction of nest sites and burrows would affect primarily small wildlife species. Because of the small acreage to be cleared for facilities and their scattered occurrence, populations should not change across the study area. Edge species, however, would increase along powerline corridors.

Construction of roads would create access and introduce noise and activity in areas which had not had such disturbances. Many old woods roads exist in the study area and would be used wherever possible instead of building new roads. If closed and reclaimed immediately after drilling ceases, there should be no impact on populations from such additional access.

Stress on individuals could be caused by exposure to unusual noise or activity. There is generally little knowledge of what noise levels are perceived by wildlife (Harrison, 1978 cited in Bromley, 1985) and it is difficult to predict the reaction of a given species or individual to a particular sound (Busnel, 1978 cited in Bromley, 1985). Certain species or individuals may learn to ignore sounds which are persistent and localized or ones which are not associated with negative experiences (Geist, 1971 cited in Bromley, 1985).

Sudden, unexpected noises or activity alarm most animals, causing them to prepare for flight or fight. This stresses the animals, takes time and energy away from other normal activities such as feeding and resting, and may decrease resistance to other environmental factors (Geist, 1978 cites in Bromley, 1985). Disturbance is most detrimental at times when the animal is already under stress, such as during extremely cold or hot weather and during pregnancy (Geist, 1971 and 1978 cited in Bromley, 1985). At these times, disturbance may result in smaller body weight, insufficient fat reserves to live through the winter, delayed maturity, increased mortality of young and decreased reproductive success (Geist, 1979 cited in Johnson and Lockman; Moen, 1978; both cited in Bromley, 1985). All these could result in reductions of long-term animal populations.

Animals may respond to noise by avoiding the source. If this happens, individuals are forced out of preferred habitat into that which is occupied by another individual or which is sub-optimal. This can result in increased predation, competition for scarce or high-quality resources, high energy use compared to intake and possibly reduced populations due to direct mortality or lower reproductive success (various authors cited in Bromley, 1985).

Sounds are an important means of communication for many species. For some species, noise can directly affect reproduction and territorial behaviors by masking communication sounds (Memphis State University, 1971 cited in Bromley, 1985). Species use sound to attract mates, declare and defend territories, intimidate predators, warn other of danger and otherwise communicate with each other. If the noise level of mine/mill and associated facility operations were high enough to blot out these species sounds, normal behaviors would be impossible. The animals would either die because they were unable to adjust, or more likely, they would avoid the source of the noise and move into other areas.

Noise and activity associated with drilling, blasting, vent shafts, traffic, the mine/mill site and other facilities could cause Cooper's and sharp-shinned hawks and ruffed grouse nesting close to a facility to desert the nest and/or young, temporarily or permanently if the disturbance was great enough. Bald eagles winter along the Eleven Point River and Swainson's warblers and great blue herons nest there. Restrictions on activities in the river zone would make it unlikely that these species would be disturbed.

Some bird species, particularly hawks, eagles, and owls sometimes electrocute themselves when trying to land on powerline supports. Many powerline wires are close enough together that these large birds can touch two wires at the same time (Olendorff, et al. 1981).

Traffic patterns in the study area would change dramatically in the vicinity of a mine/mill. Three shifts a day would mean two-way traffic between the mine and area communities three times every 24 hours. There would be an increased chance of vehicle/animal collisions during these high-volume traffic times. Species most susceptible would be reptiles, amphibians, skunks, opossums, some songbirds, rabbits, and squirrels. Most species would be more likely to be hit in early morning or evening hours and during spring, breeding season, or migration. Even under the high development scenario, the additional deaths would not be expected to change long-term populations of any species across the study area.

Undoubtedly, many construction and mine workers would participate in hunting. Some workers might also enjoy trapping. Even if all employees were hired from outside the study area, which is unlikely, the additional increase in hunting and/or trapping pressure should not have a significant impact on game populations.

Since listed species are not legally hunted, there should be no additional mortality of these species from an influx of construction personnel.

Mitigation Measures

Forest Plan standards which protect animal populations limiting disturbance associated with vehicle use and drilling operations are addressed on pages IV-30, 71, 82, and 204 of the Forest Plan.

Water quality is considered on pages IV-72 and 82. Minimum requirements are set for settling ponds, sewage treatment facilities and water storage or transmission structures; and restrictions on sand and gravel production are established.

Applied to mineral activities, these measures would limit some types of disturbance. Forest Plan standards and mitigating measures identified in response to habitat change would also reduce the likelihood of changes in animal populations due to changes in habitats.

In addition, the following measures would reduce changes in animal numbers.

Design and locate facilities to reduce disturbance and facilitate reclamation. Design and construct powerlines to allow raptors including bald eagles to land on supports without coming in contact with wires, or to discourage them from landing on supports. Olendorff, et. al. (1981), discusses several designs which would accomplish this.

Place seasonal restrictions on drilling in areas of known red-shouldered, sharp-shinned, or Cooper's hawk nests.

Use noise abatement techniques and practices. Design vent shafts to minimize noise.

The presence of additional mine employees in the study area is not likely to cause changes in population from hunting, traffic, or other disturbance. However, there are some things the company could do to encourage their employees to enjoy the area's resources while reducing the potential for unintentional damage. These include:

Development and implementation of an environmental education program for mine/mill employees. This effort should stress the ecology or the area unique habitats and species and awareness of potentially damaging activities.

Regulate traffic through carpooling or employee bussing, speed limits, restrictions on the use of all terrain vehicles (ATVs), and signing.

Prohibit carrying of firearms on company property, in company vehicles, and while on company time. Strict enforcement and automatic dismissal for violations of State wildlife regulations would further reduce the chance that employees would hunt illegally.

Use noise abatement techniques and practices. Design vent shafts to minimize noise.

Place seasonal restrictions on drilling in areas of known red-shouldered, sharp-shinned, or Cooper's hawk nests.

Effects After Mitigation

The potential for raptor electrocution would be reduced. In some cases, environmental education could help reduce the chance of unintentional harassment or disturbance to wildlife. Traffic regulation would reduce the potential for human/animal conflicts such as collisions, illegal hunting, and harassment of wildlife. Firearms prohibitions would reduce the potential for illegal hunting which has been a problem in the study area and a decrease in game populations. Disturbance to adjacent wildlife populations would be reduced as would the possibility of a decrease due to stress caused by this noise. Seasonal restrictions would prevent the nest or young of listed hawk species from being abandoned by parents which have been disturbed.

Biological Integrity (Terrestrial)

A mine/mill operation would use and produce several substances which could be harmful to terrestrial wildlife. Lead, zinc, cadmium, copper, and silver would be extracted from ore. Many reagents for the milling process are toxic in some concentration. In addition, oil, diesel fuel and gasoline would be used in equipment, and blasting compounds would be used to remove the ore.

Accidental releases of these compounds as effluents into soil or water would be possible. Such accidents could have effects on the entire biological community, depending on the amount of effluent released, length of release and substances released. The potential for such occurrences, as well as the substances which could be released, were discussed under Water Resources in this Chapter.

Release of heavy metals and/ or milling reagents could contaminate soil, vegetation, and water. Heavy metal particles can adhere to the surface of soil particles and vegetation (Kania and Nash, 1986). Some plants can absorb heavy metals into root systems or leaves and translocate these substances into other plant tissues. Some forms of metals are soluble, while other forms precipitate out in water and settle to mix with bottom sediments (Kania and Nash, 1986).

Terrestrial animals which live in close contact with contaminated surfaces (worms, moles, insects, ground nesting birds), eat contaminated vegetation (deer, rabbits, mice, some birds), sift through contaminated soil to find food (thrushes, skunks), or drink contaminated water could pick up and/or ingest these particles. Carrion-eaters such as eagles, hawks, crows, and opossums might ingest harmful substances from the flesh and skin of their food. Doves and other birds which pick

up grit from roadsides to aid digestion might also ingest heavy metals dropped from transport trucks (Kania and Nash, 1986). Terrestrial animals which feed on aquatic plant or animal species could pick up contamination. Fish-eating birds, raccoons which eat crayfish, fish, and frogs, some snakes, insect-eating bats and birds, and waterfowl are all at possible risk. Some animals might drink from the mine water clarification pond containing traces of harmful substances while others might ingest tailings (Montana Tunnels, 1985).

Many factors determine how toxic a substance is to living things. Effects may either be acute (causing immediate problems) or chronic (with no symptoms appearing until long after initial exposure). Little is known about chronic sub-lethal concentrations and the reactions of wildlife species to most of the substances resulting from mine/mill operations.

Farm animals and laboratory rats have suffered lead poisoning from various sources (McKee and Wolf, 1963), and it is reasonable to assume that most terrestrial animals would be affected in some way if there were a sudden and significant increase of lead in their system. The level of lead concentration which is safe is unknown for most species. However, the maximum safe level of lead in drinking water for animals is believed to be 0.5 mg/l (McKee & Wolf, 1963). State water quality standards, however, specify 0.05 mg/l or 50 ppb.

One study of deer in Missouri has shown that lead levels are higher in the leg bones of deer in mining areas than that of deer located elsewhere. There has been no evidence that the deer are harmed by these levels since no clinical symptoms of lead poisoning have been noted (Wixson, 1977).

The effects of lead ingestion on waterfowl have been studied in relation to lead shot. Waterfowl can and do accumulate lead in soft tissues and bones, where it remains for a long time (Kania and Nash, 1986). Lead may affect the nervous system, the transfer of oxygen to tissues, the production of hemoglobin, and can impair growth, particularly in young animals (Humburg and Babcock, 1982; Kania and Nash, 1986). Birds become emaciated and listless and can eventually starve to death (Kania and Nash, 1986.)

Copper is an essential trace element found in all plant and animal life and appears to be involved in metabolism of iron (McKee and Wolf, 1963). It is not likely to be a cumulative poison since most copper taken in is excreted by the body (McKee and Wolf, 1963). However, large doses of copper can cause poisoning, and symptoms of copper poisoning in animals include loss of appetite, copper accumulation in the liver, jaundice and yellow coloration of the entire animal. Copper sulfate, a common salt of copper which is highly soluble in water, is used in the milling process as a zinc activant.

Cadmium is insoluble in water in its elemental form and is not known to be biologically beneficial or necessary. Excessive cadmium can cause a decrease in blood hemoglobin and a reduction in growth rates (McKee and Wolf, 1963).

High concentrations of zinc can cause growth to stop, a loss of body weight, and sometimes death (McKee and Wolf, 1963). Zinc sulfate is used in the milling process as a zinc depressant.

More information is needed on the toxicity of heavy metals and milling reagents, their acute and/or chronic effects on specific organisms, and their persistence in the environment. An accidental release of effluents may or may not cause any or all of the effects discussed. It is impossible to predict which animal species might be affected and to what extent. However, it is certain that the addition of effluents to area waters would change the biological integrity of the community to some degree.

Mitigation Measures

All measures discussed under habitat and population changes would help maintain the biological integrity of the study area. In addition, the following measure would help protect water quality and thus biological integrity.

Mine tailings impoundments will not be permitted within the lease area unless additional studies conclusively show that such facilities can be constructed in an environmentally sound manner. Any subsequent decision to approve tailings impoundments will be made by the Missouri Department of Natural Resources, Forest Service and the Bureau of Land Management. This decision will be based on study findings and the preparation of appropriate environmental documentation environmental documentation in compliance with the National Environmental Policy Act.

The effects of exploration would be essentially the same for all alternatives, since the entire study area is available for exploration done under Forest Plan standards.

The entire study area would be available for leasing under Alternative B. All effects discussed could occur. Only a small percent of the study area would be affected by habitat change. If facilities were spread throughout the study area, there would be little impact to habitat or populations as a whole. If facilities were concentrated in one or two areas, changes would be more likely to be significant. Regardless of location, there would be an increase in the numbers of edge species along powerlines and roads and a decrease in numbers of interior forest species near facilities. Populations across the study area would not be affected. A large release of effluents into the Eleven Point River would have unknown, but possibly severe, effects on numbers of riparian animals and other terrestrial animals which depend on the river as a water source. In accordance with the Endangered Species Act and Forest Plan

standards, listed species and their habitat would be protected from disturbance. It is unlikely there would be an impact due to mineral activities. Biological integrity of communities would only be affected in the immediate vicinity of facilities; again with the possible exception of an accidental release of effluents into area waters, wetlands, caves or endangered species habitat.

Because Alternative D would change the visual standards to allow all mineral facilities in much of the study area - with restrictions on powerlines, tailings impoundments, haul roads and mine/mill sites along sensitive travel routes - the effects on wildlife would be the same as in Alternative B with three exceptions.

First, in the 6.2 management area, mineral development is incompatible with the area objectives and no development would take place. Wildlife in this area would not be affected by mineral activities and potential habitat would be available for black bear and possibly cougar.

Second, along travel routes where some activities are restricted, wildlife would be less likely to be physically disturbed by mineral activities. Traffic would continue to be a hazard for animals attempting to cross roads. However, no permanent change in animal populations would occur.

Third and last, animals living along and adjacent to the Eleven Point River down river from its confluence with Spring Creek would be protected from most mineral disturbance. The presence of several sensitive travelways would create a variable width buffer zone of about 2 miles on the north side of the river. This area would provide suitable potential habitat for cougar or black bear.

The effects of Alternative E would also be the same as Alternative B. Because some facilities would not be permitted near travelways, the placement of facilities could be different than in Alternative B, but the number and size of facilities needed would not change, nor would the total effects on terrestrial wildlife.

The 6.2 prescription in Alternative E would be changed to allow mineral development in that area. Therefore, effects on listed species within the 6.2 area and in the study area outside the river zone would be the same as in Alternative B.

Because powerlines and tailings impoundments would exceed visual standards, under Alternative C it would be virtually impossible to have facilities other than temporary access roads and drill sites in 80% of the study area. Mine/mill facilities and haul roads would be restricted to 30% of the study area. Therefore, there would be no effect on wildlife habitat, populations, or biological integrity within this area. In the 20% of the study area where development would be possible, the effects on wildlife would be the same as in Alternative B.

There could be a distinct difference in the types of species present between the two variety classes. With over 3000 acres of added land clearing dispersed within 20% of the study area, the north and east part of the study area would favor early successional stage species associated with annuals, perennials, and grasses. About 24% of available National Forest System lands would be needed for mineral activities, requiring vegetation clearing. This area would change form essentially forested to open and provide habitat for those species requiring early successional stages. This area currently has more private land and more open habitat than the rest of the study area. Species which favor mature forested areas or brushy successional stages would be essentially absent where mining occurred, but would be common in the visually distinctive south and west parts of the study area.

Under Alternative C there would be little effect on listed species. All known listed plants are located within the visually distinctive area. Seventeen of the 21 listed animal species known to exist in the study area are found within, or immediately adjacent to, the Eleven Point River. Eight of the 16 species possibly existing in the study area would also be found within the river zone or very near. In this alternative, all species within the river zone would be protected from habitat disturbance and population changes caused by mine operations. Water quality concerns would be the same as Alternative B because of the uncertainty about how water travels underground in the study area.

Alternative A would cause the least impact to listed species. Of the alternatives allowing mineral development, Alternative C would cause the least impact to listed species since the majority of the study area would not be available for powerlines and tailings ponds. Alternative B would have the most impact because most of the study area would be available for all mineral activity. Alternative D would provide some protection of listed species along the Eleven Point River, other sensitive travelways and in the 6.2 management area, but would allow mineral development in the majority of the study area. Alternative E would provide the same protection along travelways as does Alternative D, but allows mineral development in the 6.2 management area.

Introduction (Caves)

Since scenarios differ only in the likelihood that effects might occur, mineral activities which could potentially affect caves will be discussed in terms of potential habitat changes, population changes, and changes in the biological integrity of the cave system. Mitigating measures will be given for each type of effect. Alternatives will be compared for all effects and scenarios. State and Federally listed cave species would be affected in the same ways as other cave species.

Habitat Change (Caves)

Although Forest Plan standards prohibit drilling over known caves, it is possible that drilling could intersect unknown caves. The possibility that ore shafts, vent shafts, or drill holes might intersect caves would increase with each new facility. Small rocks, soil, and drilling fluids could enter the cave through the drill hole before the hole is cased. If the cave is dry, only a part of the cave floor would be changed. If wet, these materials could be carried through the cave and cause turbidity in the cave stream. This might affect aquatic cave organisms in the same way as aquatic communities discussed later in this chapter. Since some aquatic cave species are blind and depend on vibrations and movement for orientation (Rhodes, 1974), the added sediment would not affect their sight. However, the additional particles might cause confusion over what was prey or danger.

Erosion of soil from construction sites could enter caves through sinkholes or other discrete local recharge areas. Silt deposited on cave floors would change microhabitats and associated species. Silt could also carry in organic debris which provides food for many cave creatures (Aley, 1985).

Mitigation Measures

Forest Plan standards which apply to caves are found on pages IV-18-19 and IV-51-53. In addition, standards on pages IV-72, 82, 85, and 204 would protect cave habitats. Special habitats, such as caves, are given priority over other projects. If other projects conflict with special habitats, those projects or activities must be relocated or altered to prevent alteration of the habitat changed. All caves are to be protected by designating a 5 acre area surrounding the entrance as permanent old growth management. Water runoff from roads must be diverted before reaching this area. Closed roads must be revegetated within a year to reduce soil loss. Standards are established for settling ponds, sewage treatment facilities, and water storage or transmission structures.

An additional measure which could decrease the amount of potential soil erosion into caves would be:

Reclamation plans will include provisions for immediate stabilization and meeting Forest Plan objectives. Close and revegetate access roads immediately upon termination of use.

Effects After Mitigation

Immediate reclamation of access roads would reduce the time soil was exposed to erosional forces and the potential for sediment to reach cave waters, altering aquatic cave habitat.

Population Change (Caves)

Drill sites, vent shafts, or mine/mill sites would not be permitted over known caves, although the potential for sites to be located close to caves would increase with each new mine/mill developed. Depending on the location of sites, individual caves could be close enough to be disturbed by traffic or blasting vibrations, or noise from vent shafts and the operation of other facilities. It is not certain how close these activities would have to be before they would be adverse to cave populations. Although possibly significant to one or more individual species or caves, this type of disturbance is not likely to be significant throughout the study area.

The presence of new access roads could make some caves easier to get to than they are now. This might encourage more people to visit individual caves, resulting in disturbances. Sources of disturbance to cave creatures would include heat and light from lamps and flashlights, vibrations from walking, trampling, and intentional or unintentional killing of creatures (Mohr).

Bats, including Federally endangered gray and Indiana bats and two State rare bat species, are particularly sensitive to disturbance. Past human disturbance is one of the primary causes of decline in some bat populations (U.S. Fish and Wildlife Service, 1982 and 1983). If disturbed during hibernation, they become active, using energy from fat reserves required for dormancy. If too much of the fat reserve is used, the bats will awaken before insects are available and could starve (Mohr). After young are born in the spring and before they are able to fly, mother bats who are disturbed may dislodge the young who will then die. Both of these situations could contribute toward permanent reduction in bat numbers, including Federally endangered and State rare bat species.

Bats may also desert a cave if the disturbance takes place often enough or at critical periods, particularly when returning to summer caves or hibernacula. Since a cave is usually chosen because it meets very specific habitat requirements, another suitable cave may be difficult or impossible to find (Twente, 1955; Hall, 1962; Henshaw, 1972; all cited in Mohr; Tuttle and Stevenson, 1977). The bats may die of exposure, or become weakened by attempts to compensate for less than adequate habitat (Mohr). Colonies which attempt to relocate usually die out in time (Clawson, personal communication). Also, because bat guano can be an important energy source for caves, loss of the bats can adversely affect other cave inhabitants, such as State watchlisted southern cavefish (Mohr).

Mitigation Measures

Forest Plan standards would protect populations by limiting disturbance near caves on (pages IV-30, 71, 82, and 204). Such standards limit off-road vehicle use, prohibit drilling within buffer zones where many caves are located, describe the planned road system, and prohibit exploration along parts of the Eleven Point River zone and at certain times of the year. Implementation of these standards would reduce

the potential for area users to disturb cave creatures through exploring caves and would minimize the chance that mineral activities would be located near enough to caves to cause disturbance.

Other measures which would reduce the chance of population changes caused by disturbances are:

Design and locate facilities to reduce disturbance and facilitate reclamation. No surface occupancy within five acres surrounding a cave entrance. This would reduce the potential for noise or activity to disturb cave creatures.

Reclamation plans will include provisions for immediate stabilization and meeting Forest Plan objectives. Close access roads immediately after use. Roads needed for long-term use could be gated to prohibit public use.

Use noise abatement techniques and practices.

Lessee must develop and implement an environmental education program for mine/mill employees. Such a program would inform workers of the sensitive nature of caves, their ecological value, and the proper methods of enjoying caves.

Effects After Mitigation

Immediate closure of roads could reduce access to caves and the amount of visitation. A reduction of vent shaft noise would reduce the chance that cave species would be disturbed, which could eventually result in reduced populations. An environmental education program could increase appreciation for cave creatures and reduce the chance of unintentional harassment or disturbance.

Biological Integrity (Caves)

Cave systems could be affected by mineral operations primarily through the potential release of substances into the groundwater system. A potential drop in the water table is another aspect of mine operation which would be of concern.

The discussion of water quality in this chapter addressed the ways in which effluents such as heavy metals, milling reagents, gasoline, and oil could enter the groundwater system and be transported into caves.

Cave creatures exposed to heavy metals, either particulate or dissolved, undoubtedly would ingest, absorb, and/or adsorb small amounts. Given the highly alkaline groundwater of the study area, it is unlikely that significant toxic effects would occur, but this has not been tested or proven. Whether or not there might be sub-lethal chronic effects is more difficult to assess, and is unknown.

Fugitive mill reagents would probably pose a greater hazard to cave life than heavy metals. Although their toxicity to cave species is unknown, several reagents are known to cause mortality among some surface-water organisms at concentrations in the parts-per-billion range (Wixson, 1977, pp. 447-464). It is believed that sub-lethal chronic effects occur at even lower concentrations.

A sudden release of undiluted reagent probably would be more devastating to cave life than a slow trickle, due to lower concentration. Conversely, sudden releases tend travel through from the groundwater system rather quickly. Recolonization of the affected area could be fairly rapid if there were individuals in unaffected areas connected to the affected cave system. However, some species are not good pioneers, even at short distances, and might fail to recolonize. The loss of even one species in the closely dependent cave community could affect the entire community.

Petroleum products such as fuel and lubricants could reach the cave environment as a result of transportation accidents or storage leaks. Gasoline is extremely mobile in groundwater and almost impossible remove. A gas or oil film on water can interfere with oxygen/carbon dioxide exchange, coat bodies of fish, and result in a direct toxic effect (McKee and Wolf, 1963). Oil can also interfere with food organisms and may absorb to clay or silt particles, settle out, and persist under turbid conditions (McKee and Wolf, 1963).

Gasoline and sewage effluent can cause oxygen depletion (Aley, 1985). Cave waters at saturation normally have 10-12 ppm dissolved oxygen and are slower to reoxygenate than surface waters (Aley, 1985). Low dissolved oxygen can cause respiratory distress, random movements, avoidance reactions, and death (McKee and Wolf, 1963). Egg hatches can be delayed or fish fry can be deformed under oxygen-deficient conditions (McKee and Wolf, 1963). Optimum dissolved oxygen levels vary between species and are generally not known. In order to maintain a varied fish community in good condition, it has been recommended that dissolved oxygen measure at least 5 mg/l (McKee and Wolf, 1963).

Whether or not aquatic cave species would be adversely affected by petroleum products probably depends on their sensitivity to soluble petroleum fractions rather than to the entire product. Some reports indicate that cave fish have survived beneath floating layers of chemically potent crud in Kentucky (Crawford, personal communication), even though observations are unproven. There are also many kinds of aquatic cave life other than fish for which little is known that sheds light on this matter.

Mayflies, stoneflies, and caddisflies are the major food source for Federally endangered gray bats (U.S. Fish and Wildlife Service, 1982). In some streams of the Viburnum Trend, mayfly and stonefly populations decreased dramatically as a result of organic pollution from milling and from tailings filling up riffles and pools (Ryck, 1973). Populations recovered when the pollution was stopped.

A change in water quality as a result of mine/mill effluents would reduce numbers of may, stone and caddisflies in study area waters. This could, in turn, reduce populations of gray bats along the Eleven Point River. Further information can be found in Appendix 9.

Water-level fluctuations are a normal part of many cave systems, providing food in the form of washed-in organic matter and triggering reproductive behaviors in some creatures (Poulson and Smith, 1969; Jegla and Poulson, 1970; Barr, 1968 among others; all cited in Tuttle and Stevenson, 1977). It is unlikely that fluctuating groundwater levels would result in any major adverse effects to aquatic cave life. Natural groundwater fluctuation from precipitation is greater than fluctuations potentially caused by minerals activities. Groundwater flow velocities in the caverns where most cave life is found also vary widely. The fact that aquatic cave life exists under highly variable and sometimes rapidly changing natural conditions suggests that cave species can tolerate change.

To what extent a permanent drop in water level could be harmful is not known. The lowering of the existing water table due to mine de-watering operations could cause several problems. Many cave organisms are dependent on very specific humidity and moisture factors (Barr, 1959, 1961, 1967; Vandel, 1965; all cited in Tuttle and Stevenson, 1977). Changes in cave water levels could change the humidity and reduce the amount of habitat available for aquatic cave creatures, forcing individuals to compete for scarce resources. As a result, populations could decrease.

Mitigation Measures

In addition to the measures already discussed for habitat and populations, there are several Forest Plan Standards which protect water quality and thus biological integrity of caves (pages IV-72 and 82).

Tailings disposal must meet the state "no discharge" requirement.

Effects After Mitigation

Use of alternate tailings disposal methods would reduce or eliminate the risk of accidental spills or leakage which would probably have adverse effects on cave communities.

The effects of exploration would be the same for any alternative.

Under Alternative B, all effects discussed would be possible. Because mineral activities would be permitted throughout the study area, effects would be most likely to occur under this Alternative. Habitats could change and populations decrease in one or more caves. Changes in water quality or quantity resulting from the release of effluents into groundwater would affect individual cave communities to some degree, possibly severely. The potential for the occurrence of such effects would increase with each additional mine/mill.

There are several caves located in the 6.2 management area which would not be affected under Alternative D. Caves located along the Eleven Point River corridor would also be protected from disturbance. The effects on all other caves would be the same as under Alternative B.

Under Alternative E, caves located along the Eleven Point River would be protected from disturbance. Effects on all other caves in the study area would be the same as those under Alternative B.

All caves under Alternatives B, D, and E could potentially be affected by changes in water quality or quantity since groundwater travels many miles.

Under Alternative C, all known cave entrances would be located within the visually distinctive area. There would be no effects from noise and activity near the caves. Effects from cave visitors would be the same as under Alternative B, since there would be no difference in numbers of workers.

Even though no mine(s) would be located within the visually distinctive area because of the restrictions on powerlines and tailings disposal sites, dye traces have shown that water moves differently underground than on the surface. Therefore, although the chances for accidental releases of effluents to affect caves may be less when the facilities are located farther from the cave, the possibility would not be eliminated altogether.

It is unlikely that mine dewatering operations would cause any temporary or permanent drop in the water levels of any caves under Alternative C, since any mines would be located away from known caves.

Introduction (Aquatic)

Mineral activities which affect habitats, populations, and biological integrity will be discussed separately. The major difference in the scenarios is the potential for effects to occur. In the high development scenario, the presence of eight mines area would increase the risk of accidental water contamination. Mitigating measures will be discussed. State and Federally listed threatened, endangered, rare, or sensitive species would be affected in the same way as other aquatic species and are included in the discussion.

Habitat Change (Aquatic)

The major construction activities which could have an impact on aquatic habitats include a mine/mill site clearing, access roads, utility line corridors and other facilities. The chance of a significant amount of soil reaching area waters would increase with each additional facility constructed and operated. Soil loss

and its effects on area waters might also be of longer duration where there were several facilities being constructed over a long time period as in the high development scenario.

Clearing for mineral activities would cause soil disturbance and possible stream sedimentation in localized areas. Increasing the sediment load of a stream can increase turbidity, which in turn can interfere with photosynthesis, decreasing the production of plants upon which other organisms feed. Low light conditions caused by turbidity would make it difficult for some fish to find food. Small fish would be better protected from predators.

A large release of tailings could also cause high turbidity. The effects would be the same as soil-caused sedimentation or turbidity.

Most streams in the study area are periodically subjected to flooding which scours the bottom and prevents any permanent buildup of silt. Small amounts of sediment entering the streams or large amounts for short durations should not cause any long-term changes or permanent adverse impacts on the aquatic habitats in the study area.

If mine dewatering caused permanent reductions in surface water levels, there would be less water surface and area available as habitat. It is possible that some permanent water could become dry year-round or intermittently. Those habitats would then be unavailable.

It is unlikely that sedimentation from construction of mine/mill structures and associated facilities would have any effect on Current River habitats because of the distance between the river and the study area boundary.

Mitigation Measures

There are several Forest Plan standards that would help protect water quality and thus aquatic habitats (pages IV-47, 49, 52-54, 71-73, 82, 85, and 204). Buffer zones are established for permanent water and restrictions placed on activities within those zones. Temporary roads must be constructed to minimize soil and streambed disruption. Rehabilitation standards are set to minimize soil loss. Restrictions are set for sand/gravel production from stream channels. Limitations are given for activities within the Eleven Point National Scenic River zone. Standards are set for settling ponds, sewage treatment facilities, and water storage or transmission structures.

Another measure which would reduce the potential for aquatic habitat change would be:

Minimize wind-blown contaminants. Cover vehicles hauling concentrate.

Effects After Mitigation

Covering haul trucks would reduce the chance of heavy metals entering the water and changing habitats.

Population Change (Aquatic)

Suspended solids and silt washed in from construction activities could cause abrasive injuries to shellfish, fish and other aquatic animals. Such pollution could also clog gills and respiratory passages of some aquatic animals, and could cover the bottom of streams smothering eggs, young, and food organisms, destroying spawning beds, and filling pools (McKee and Wolf, 1963). The species composition of a stream could change if this condition persisted. Populations of species which require low levels of suspended solids could decrease or disappear, to be replaced by species adapted to higher levels. Most mussels, for example, cannot live where there is a 1/4" to 1" layer of silt over the bottom and some mussels will slow their feeding rate when silt and suspended solid concentrations are high (McKee and Wolf, 1963).

The same effect could occur if there were a large release of tailings into area waters.

If water levels were changed as a result of mine dewatering activities, there could be some effect on aquatic animals. A drop in water level would decrease the amount or quality of habitat available for some species. There would be increased competition for available space and an eventual reduction in populations. Other species, depending on those reduced populations for food, could also decline. The exact effect, and the significance of the effect on different species is unknown.

Mine/mill employees would more than likely fish on area rivers and streams. This increase in fishing pressure should not change fish population densities or species composition. If fishing pressure should become heavy, Missouri Department of Conservation regulations could be adjusted to maintain healthy populations.

It is unlikely that populations in the Current River would be affected by mineral activities occurring within the study area, since those activities would be many miles from the river.

Mitigation Measures

A measure which could in some cases reduce the chance of unintentional harassment or disturbance of wildlife would be:

Lessee must develop and implement an environmental education program for employees. This could increase appreciation for aquatic species and reduce the chance of unintentional harassment or disturbance of these species.

Biological Integrity (Aquatic)

A major source of concern regarding mine/mill operations would be the release of milling reagents and other substances on water quality and consequently on aquatic communities. These substances would be generated and disposed of in several ways. These are discussed in the water section of Chapter Four.

Historically, insoluble heavy metal forms in an alkaline aquatic environment, such as that present in the study area, were thought to be biologically inert. Research in the Old Lead Belt and Viburnum Trend, however, has reversed this view. It is now known that insoluble metals, as well as soluble metals, can accumulate on and in plant and animal organisms (Wixson, 1977; Schmitt and Finger, 1982).

Insoluble metals are precipitated from water and fall to the stream bottom where they are adsorbed onto sediment particles (Kania and Nash, 1986; McKee and Wolf, 1963). These metals can then collect on the surface of plants and animals which come in contact with them and can be absorbed through roots, stems and leaves and incorporated into plant tissues (Wixson and Bolter, 1972; Gale et al., 1973; both cited in Schmitt and Finger, 1982). Aquatic algae can accumulate both particulate and dissolved metals on their tissue surfaces. The metals are extracted from stream bottom sediments and absorbed from water.

Metals are passed on to aquatic animal forms through the food chain. The availability of metals and other substances to aquatic organisms and the effects on different organisms is influenced by the type of metal, the length of exposure, pH, hardness, and other physical and chemical properties of the water. The toxicity of most of these metals is greatly reduced in the presence of hard water such as that occurring in the study area (McKee and Wolf, 1963). Limits suggested for maintenance of aquatic communities for some metals are: dissolved Lead <= 0.1 mg/l and Copper <= .02 mg/l (McKee & Wolf, 1963).

Research in the Viburnum Trend and Old Lead Belt has shown that organisms, including aquatic insect larvae, crayfish, mussels, tadpoles and fish, tend to concentrate metals more on external surfaces and in digestive tracts, shells, scales, gills, bones, brain, skin and fatty tissues, than in muscle tissue.

Bottom-dwelling organisms are very likely to come in contact with contaminated sediments if effluents are released into streams. Research has shown that numbers of benthic organisms have been reduced in the Big River of the Old Lead Belt (Czarnezki, 1985). These organisms are important food sources in the aquatic food chain and may pass along contaminants to other organisms. A reduction in numbers would force other organisms to compete for a limited food supply or find food elsewhere.

Plankton tend to concentrate certain metals such as copper. Since plankton are a primary food source for many other aquatic organisms, these concentrations would be passed along the food chain. The plankton may lose color, reproductive power, or die if exposed to high enough concentrations of metals or reagents (McKee and Wolf, 1963). Large population sizes make it likely that rapid recolonization of an area would occur even if an accidental release of mine/mill effluent should cause a die-off of plankton.

Mussels feed on plankton filtered from water and could ingest heavy metals, which concentrate in shells and soft tissues (Schmitt and Finger, 1982). Unlike other more mobile animals, mussels are unable to move very far to escape local concentrations of harmful substances (McKee and Wolf, 1963).

Crayfish are in almost constant contact with stream bottoms and would easily pick up metals from contaminated sediments and from feeding. After molting, crayfish commonly eat the shed exoskeleton (Kania and Nash, 1986) and ingest any metals adsorbed onto it. Other animals which eat crayfish (raccoons, kingfishers, fish), would also ingest metals. Lead can also be absorbed through the gills, affecting crayfish respiration (Kania and Nash, 1986).

Bottom feeding fish such as suckers can pick up heavy metals from the sediment stirred up during feeding and from the organisms and detritus they feed on (Czarnezki, 1985). These metals are adsorbed onto the surfaces and also incorporated into internal body tissues. Other fish may concentrate metals on skin, scales, gills, and other body surfaces. The sensitivity of individuals to these substances depends on the age, species, general condition, and physical and chemical properties of the water.

Lead and zinc can coagulate with mucous to form a film over the gills and body of fish causing death by suffocation (McKee and Wolf,1963).

Very low concentrations of cadmium can be toxic to fish, but the lethal dose varies widely (McKee and Wolf, 1963). Copper is also lethal at very low concentrations (McKee and Wolf, 1963).

Fish and other aquatic animals in the grossly metal-contaminated portion of the Big River (Old Lead Belt) generally contain higher metal levels than those in the Viburnum Trend (Czarnezki, 1985). Redhorse sucker, in particular, concentrate lead to dangerously high levels in the meat; and the practice of cooking sucker meat with skin and bones included makes them additionally unfit for human consumption. Longear sunfish occasionally have dangerously high metal levels in the meat. Catfish and smallmouth bass, on the other hand, do not (Schmitt and Finger, 1982).

Oil, reaching area streams in mine water discharges, or from accidental spills, could adhere to gills and interfere with respiration or coat the bottom of a stream, destroying benthic organisms and spawning beds (McKee and Wolf, 1963). Surface films of oil kill free-swimming mussel larvae. Algae and plankton may also be killed by oil in water. Fish living in oil-contaminated water may taste bad (McKee and Wolf, 1963).

Twenty years of Missouri Department of Conservation research in the Viburnum Trend has shown that aquatic insect diversity may be reduced in streams receiving mine/mill

discharges. Diversity reductions have ranged from minor to extreme.

Total aquatic insect numbers in the Viburnum Trend have responded to mine/mill discharges in a variety of ways. Reductions have occurred in some receiving streams while large increases have occurred in others. Mayfly (Ephemeroptera) and stonefly (Plecoptera) taxa were most seriously reduced, while dobsonflies (Megaloptera) and flies (Diptera) most often benefited.

Experience in the Viburnum Trend has demonstrated that termination of mill effluent discharges to streams can return aquatic insect communities to their original condition, if a nearby source of replacement organisms exists. Because the State water quality plan prohibits intentional mill effluent discharge in the study area, no adverse effects on aquatic insect communities would be expected unless an accident occurred. Even if an accidental release occurred, insect communities would be expected to rebound rapidly once the discharge was terminated.

Laboratory experiments have confirmed that some milling reagents are debilitating or toxic to fish and other aquatic organisms at extremely low concentrations. Sodium cyanide, copper sulfate, and xanthates are all known to be highly toxic to aquatic organisms in low concentrations (Montana Tunnels, 1985). Not all species, however, are equally susceptible. Some are killed, while others are unaffected at the same contaminant level. Many reagents are biodegradable and, given enough time in a holding facility, would break down (Wixson, 1982).

Experiences from the Old Lead Belt and the Viburnum Trend give an indication of adverse impacts to fish and aquatic insects which are possible. Regulations and new technologies which have been implemented since the advent of mining in these areas make it less likely for the types of effects discussed above to occur in any new mining operation. Industrial compliance with the no-discharge requirements of the State water-quality plan would assure far less release of metals in the aquatic environment of the study area than in the Viburnum Trend area. Barring a massive accidental escape of metals, such as in a tailings impoundment collapse, mining and milling in the study area should have no discernible effect on the edibility of fish from nearby streams.

However, more information is needed regarding sub-lethal effects, toxicity, and persistence in the aquatic environment of milling reagents and heavy metals. It is impossible to definitely predict the effects of accidental releases on different species. It is certain that changes in water quality or quantity would cause a change in the biological integrity of the affected communities.

Mitigation Measures

All measures discussed under habitat and population changes would help maintain biological integrity. Another measure which would help maintain water quality and thus biological integrity of aquatic communities is:

Tailings disposal must meet the State's "no discharge" requirement.

Effects After Mitigation

Use of alternate tailings disposal methods would reduce the chance for accidental spills or leakage and help maintain biological integrity of aquatic communities.

Exploration would have no permanent effect on aquatic habitats, populations, or biological integrity under any Alternative.

All effects discussed would be possible under Alternative B. Habitat change due to sedimentation would probably be worse if all facilities were located close together than if dispersed throughout the study area. Population changes would be unlikely unless water quality were affected by release of mill effluent. Biological integrity would also be compromised if water quality were affected.

An accidental release of mine/mill effluents into area waterways would be possible in any alternative, and would increase with the addition of each mine/mill. The effects of such a release would depend on several factors - among which are the location of the release, the amount and duration; the substances released; and the physical and chemical characteristics of the receiving waters.

Under Alternatives D and E, there would be some protection from sedimentation for the Eleven Point River due to restrictions on facilities along sensitive travelways. It is unlikely that low development activities would cause sedimentation problems for aquatic communities. If all eight mines of the high development scenario were located along the river and constructed concurrently, it is possible that there could be some impacts due to sedimentation.

The potential for unintentional release of effluents would be basically the same as under Alternative B since most of the study area would be available for development. There would be some additional protection of the Eleven Point River due to restrictions on facilities adjacent to sensitive travelways and the presence of the 6.2 Management Area where development would not be compatible with area objectives under Alternative D. However, if effluent reached the river, effects would be similar to those discussed in Alternative B.

Under Alternative C, sedimentation from construction of mine facilities could occur in the Eleven Point River if a mine were located in the southeast corner of the study area or in the visually common area where it approaches

the upper Eleven Point near Cane Bluff and Denny Hollow. Other than these locations, there would be no discernable effect on the Eleven Point from construction because the facilities would be located many miles away. Therefore, habitat would not change due to sedimentation. It is very unlikely that populations would change under this alternative.

Because visually distinctive area would not permit powerlines, tailings disposal sites, or haul roads, it is unlikely that a mine or mines would be located in this area, which comprises 70% of the study area. Therefore, it is less likely that a release of effluents would affect water quality and aquatic communities of the Eleven Point River and other permanent waters, all of which are located in the visually distinctive area. However, the karst terrain makes it difficult to predict where a release of effluents to the groundwater might end up.

Potential effects to the Current River from an accidental release of effluents would depend on where the release occurred and whether it entered the groundwater system at a place which discharges into the waters of the Ozark National Scenic Riverways. Until site specific proposals are made, it is not possible to determine whether any alternative would protect the Current River from such pollution.

ECONOMIC AND SOCIAL ENVIRONMENT

Public review comments indicated considerable interest in the effects that any mineral-development project(s) might have on the economy, jobs or people's lifestyles. The concerns were voiced from all sides of the issue. Some expressed an interest in additional jobs and income to boost the local economy. Others expressed an interest that such jobs and income would be only temporary, with possible adverse effects on local lifestyles and existing industries such as recreation and tourism.

The social and economic effects were assessed for each of the alternatives. The economic and social effects on jobs, income and population were projected using IMPLAN. IMPLAN is a computer system consisting of several software programs used to construct input-output models. The model was used for constructing an input-output model for the six-county analysis area (Figure 15). A detailed discussion of the input-output model constructed using IMPLAN can be found in Appendix 11.

DEMOGRAPHIC EFFECTS

The effects on population from mineral-development activities could be of two types: changes in total numbers or changes in distribution. Changes in demography of the analysis area could result from several factors: (1) direct in-migration due to mine construction and operation; and (2) indirect and induced effects on population as a result of a mine project.

Under Alternative A, the population of the analysis area would not change. This alternative would not allow leasing within the study area, so the projected outputs from that portion of the Forest would be the same as in the Forest Plan.

As part of a regional economic-growth study of the United States, NPA Data Services has made county-level population projections for the six-county area. Table 25 displays the projections for the area, as compared to 1985 populations. The population of the area is expected to increase by 6.6 percent between 1985 and 2000. Howell and Carter Counties should experience the most rapid growth, while Oregon County would have the lowest percent change in population. These projections were made under the assumption that mineral development would not occur in the area.

TABLE 25
ANALYSIS AREA
POPULATION PROJECTIONS
(Thousands of persons)

County	1990	1995	2000
Butler	38.3	38.7	39.2
Carter	6.0	6.3	6.5
Howell	31.8	32.9	33.5
Oregon	10.3	10.4	10.4
Ripley	13.3	13.7	14.0
Shannon	8.0	8.1	8.2
Analysis Area	107.7	110.1	111.8

Source: NPA Data Services, Inc., 1985

Table 26 shows the projected population changes for Alternatives B, C, D and E based on IMPLAN model projections. These projections were made under different assumed levels of mineral development and are in addition to those in Table 25. The figures include all workers and their families moving into the analysis area. As a percent of the existing six-county population, such increases would represent a less than two percent change. The construction and operational phases of a mine and mill could affect the population of an area differently and, for this reason, these effects are separated throughout this analysis.

Under Alternatives B, C, D and E, the population effects would be considered the same, but with significant differences between each scenario. Population changes for the exploration scenario are not shown in Table 25 because they were considered extremely low (less than 10).

The low-development scenario would be expected to create a population increase of 210 during project construction and 130 during the mine production phase. Based on the time profiles

TABLE 26
PROJECTED POPULATION CHANGES BY SCENARIO

Project Phase	Scenario 2/		
	Exploration	Low Dev.	Dev.
Exploration	0	1/	1/
Construction	na	210	350
Production	na	130	1,280

1/ Effects for this phase are less than 10.
2/ Effects are the same for Alternatives B, C, D, and E.

Source: USDA-Forest Service, 1987.

(Figure 4), the greatest population changes would occur within a 4-year period for the construction phase, and over a 15-year period during production from the mine.

The high-development scenario would have the greatest effects on population. The population increase during project construction would be around 350, and 1,280 during mine operation. Although the effects would be greater than the low development, they are spread over a longer time. Population change during mine construction would occur over an 18-year period, and over a 28-year period for production. Again, these changes are based on the previously discussed time profiles.

Table 27 summarizes the potential in-migration of workers, directly or indirectly related to the mining industry, to the analysis area by alternative. As a percent of the existing six-county population, such increases would represent a less than 1/2 of one percent change.

TABLE 27
POTENTIAL WORKER IN MIGRATION

Project Phase		Alt. C, D and E Scenario		
	Alt. A	Expl.	Low	High
Construction	0	na	60	122
Production	0	na	20	571

Source: USDA-Forest Service, 1987.

Table 28 summarizes the new households that could be potentially created under each alternative. These figures assume that the average household size is around 3.0 persons.

TABLE 28
POTENTIAL CREATION OF NEW HOUSEHOLDS

Project Phase		Alt. C, D and E Scenario		
	Alt. A	Expl.	Low	High
Construction	0	na	20	41
Production	0	na	7	190

Source: USDA-Forest Service, 1987.

The distribution of these new workers and their households would depend on housing availability and personal preferences. Since the study area is predominantly within Shannon and Oregon Counties, it is possible that greater population effects could occur in these counties. In this case, the towns most likely to experience the greatest population change would be Winona, Birch Tree and Alton.

It is not known how many construction workers and their families would remain in the six-county area as permanent residents after the construction phase. Some would be temporary and leave the area, whereas others would remain depending upon such things as the economic and social ties of family and community. Some workers might find work requiring similar or related skills during the mine production phase.

Depending on the scenario, a significant percentage of the mine-related population could leave the six-county area at the close of operations. It is not known how many people would leave after permanent mine closure. This would depend on many different factors such as the possibility of early retirement, other opportunities to earn income, or ties to community, family and friends. Most of the population decline would occur gradually, because of the staggered start-up times of different mines, and on-going reclamation activities.

Because in-migration would occur over a long time and would be small relative to the population base of the analysis area, there would be little noticeable change in the demographic environment of the area under any of the alternatives or scenarios.

ECONOMIC EFFECTS

Economic impacts occur when an industry experiences a change in the final demand for its output. For this analysis, the economic effects of the different alternatives have been separated into the categories of employment, income, economic base, and returns to government. As with the demographic effects, the economic impacts of a given scenario were considered to be essentially the same for Alternatives B, C, D and E.

Employment

Under Alternative A, leasing would not be allowed in the Study Area, so the projected outputs from that portion of the Forest would be the same as in the Forest Plan. These outputs are summarized in Table 29, and they represent the base with which the economic effects of Alternatives B, D, D and E will be compared. Even though exploration would still be allowed under Alternative A, companies would be extremely reluctant to allocate scarce funds to an exploration program when there is no possibility of obtaining a lease. It was, therefore, assumed that there would be no exploration activity under Alternative A.

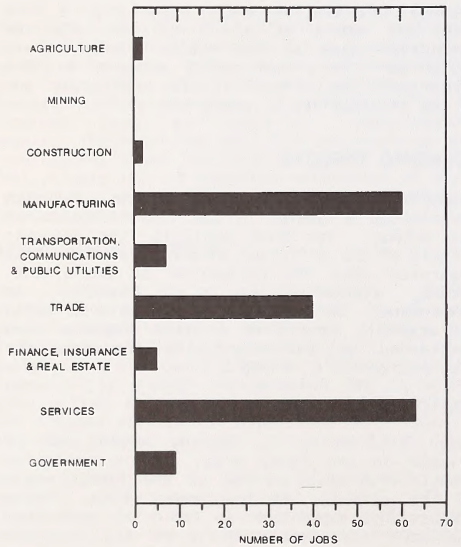
A total of 188 jobs in the six-county area can be attributed to the Study Area outputs under

TABLE 29
PROJECTED STUDY AREA OUTPUTS, 1995

Output Description	Unit of Measure	Output Quantity
Timber:		
Sell Volume	MMBF	8.00
Recreation:		
Semi-Prim, Non-Motor	MRVD	7.75
Semi-Prim, Motor	MRVD	37.24
Roaded Natural	MRVD	113.90
Wildlife:		
Use	MWFUD	59.60
Range:		
Use	MAUM	0.67
Forest Service Expenditures:		
Salary	MM1985$	0.45
Non-Salary	MM1985$	0.25

Source: USDA-Forest Service, 1987.

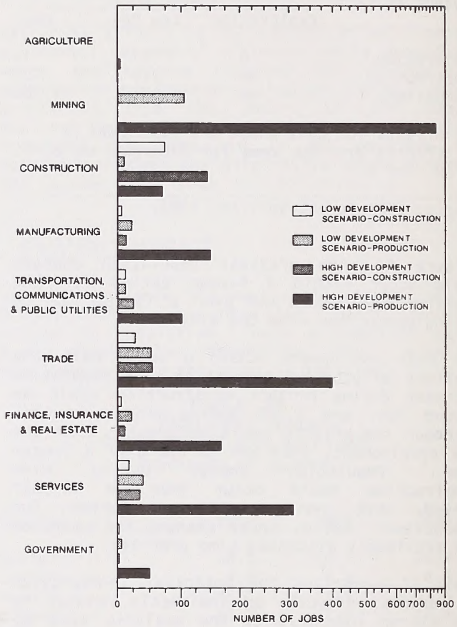
FIGURE 28
EMPLOYMENT ATTRIBUTABLE TO STUDY AREA OUTPUTS



Source: USDA-Forest Service, 1987.

Alternative A, and the distribution of these jobs among major industrial sectors is shown in Figure 28 and Table 30. The largest number of jobs is in the services sector, followed by manufacturing, and trade. Within services, 36 positions result from the study area outputs in the eating and drinking places industry with another 7 jobs in hotels and lodging places. These effects result primarily from the direct impact of recreation activity in the Study Area, which is also the case for the 15 jobs in recreation related retail trade. The 11 positions in the "other" (i.e., nonrecreation related) retail trade category, on the other hand, are generated mainly because of the induced impacts of the Study Area outputs. Of the 60 manufacturing jobs, 46 are in the sawmills and planning mills industry. The bulk of these are due to the direct impact of timber sales in the study area.

FIGURE 29
CHANGE IN EMPLOYMENT FOR ALTERNATIVES B, C, D AND E



Source: USDA-Forest Service, 1987.

Under the exploration scenario of Alternatives B, C, D and E, the drilling program would directly support 7 jobs in the analysis area and generate several other jobs from the indirect and induced effects. The employment impacts of the low development and high development scenarios of Alternatives B, C, D and E would be substantially larger and are summarized in Tables 31 through 34 and in Figure 29. It should be noted that these jobs are over and above those of Alternative A.

It was assumed that the output levels listed in Table 29 would not change in any of the scenarios of Alternatives B, C, D and E. It

TABLE 30
EMPLOYMENT IMPACTS OF ALTERNATIVE A

Sector	Effects			
	Direct	Indirect	Induced	Total
Agriculture	1	1	0	2
Mining	0	0	0	0
Construction	0	2	0	2
Manufacturing	51	7	2	60
Transportation, Communications, Public Utilities	2	4	1	7
Trade	23	7	10	40
Finance, Insurance, Real Estate	0	3	2	5
Services	45	7	11	63
Government	8	1	0	9
Total Jobs	130	32	26	188

Source: USDA-Forest Service, 1987.

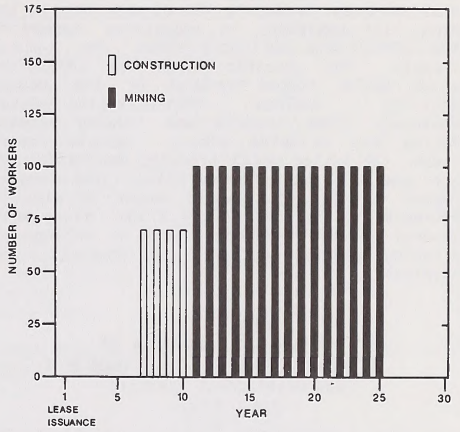
was recognized, however, that some recreation users might choose to avoid the immediate vicinity of the mining activity, but based on the professional judgement of those knowledgeable of recreation on the Forest, any loss in recreation users would be offset by others attracted to the area, either specifically because of the mining or, more generally, because of greater accessibility resulting from more roads.

In addition to analyzing the economic effects separately by scenario, it is also necessary to distinguish between the impacts of construction and production. Figure 30 presents a time profile of the direct construction and mine employment for the low development scenario. Under this scenario, construction begins in year 7 and the direct impact is assumed to be 70 jobs per year for the 4-year construction period. Construction employment will, however, vary depending upon the exact stage of construction, and for a mine of approximately this size, construction employment can range from 12 to 98 (Matt Caco, pers. comm., May 19, 1987).

A total of 141 jobs would be created from activities in the construction phase of the low development scenario with 70 due to the direct impact on the construction industry. As a result of the indirect impacts, employment would increase by 47 with the largest effects being felt in trade and transportation, communications and utilities. Nonrecreation-related wholesale trade would account for 15 of the 18 trade jobs, while the majority of positions in the transportation, communications, and utilities sector would be in motor freight transport.

Another 24 jobs would be created from the induced impacts. Slightly less than half of these would be scattered among various service industries, while nine jobs would be in trade, primarily nonrecreation-related retail trade. Once the construction phase of the low

FIGURE 30
TIME PROFILE FOR CONSTRUCTION AND MINE EMPLOYMENT
(Low Development Scenario)



Source: USDA-Forest Service, 1987.

development scenario is completed in year 10, construction-related employment would begin to decrease. All 141 jobs would not disappear instantaneously, however, as it may take one year or more for employment in supporting industries to contract to former levels. The 24 jobs created from the induced impacts of the construction activity would be eliminated at an even more gradual rate. Also, potential job losses in some industries may be avoided entirely because of the positive employment impacts of the subsequent production phase.

TABLE 31
EMPLOYMENT IMPACTS FOR ALTERNATIVES B, C, D and E
(Low Development Scenario-Construction)

Sector	Change			
	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0
Mining	0	0	0	0
Construction	70	2	1	73
Manufacturing	0	5	1	6
Transportation, Communications, Public Utilities	0	11	1	12
Trade	0	18	9	27
Finance, Insurance, Real Estate	0	4	1	5
Services	0	7	10	17
Government	0	0	1	1
Total Jobs	70	47	24	141

Source: USDA-Forest Service, 1987.

In the low development scenario, production would begin in year 11, and Table 32 shows the distribution of employment, by sector and type of impact, for this scenario and phase. A total of 265 jobs would be created in the analysis area, including 100 direct jobs in the mine, 131 positions in industries supporting the mine, and 34 jobs from the induced impacts. The specific supporting industries which would expand because of the mining activity include nonrecreation-related wholesale trade, hotels and lodging places, eating and drinking places, vehicle repair shops, fabricated metal products manufacturing, and sawmills and planing mills. The induced impact of 34 jobs would occur mainly in nonrecreation-related retail trade, along with several service industries such as eating and drinking places, doctors and dentists, and hospitals.

TABLE 32
EMPLOYMENT IMPACTS OF ALTERNATIVES B, C, D and E
(Low Development Scenario-Production)

Sector	Change			
	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0
Mining	100	4	0	104
Construction	0	8	1	9
Manufacturing	0	20	2	22
Transportation, Communications, Public Utilities	0	11	1	12
Trade	0	39	13	52
Finance, Insurance, Real Estate	0	19	2	21
Services	0	25	14	39
Government	0	5	1	6
Total Jobs	100	131	34	265

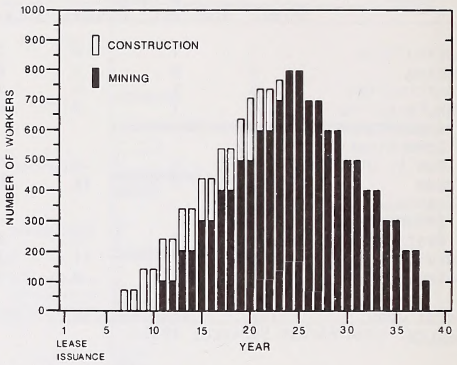
Source: USDA-Forest Service, 1987.

In addition to the employment generated from the construction and mining activity in the low development scenario, there would also be an ongoing drilling program. The impacts of this program would be similar to those outlined in the exploration scenario.

The time profile for direct construction and mine employment in the high development scenario of Alternatives B, C, D and E is shown in Figure 31. As under the low development scenario, construction begins in year 7 and production in year 11, so the economic impacts are not significantly different from the low development scenario until year 9, when construction of a second mine begins. Year 23 would be the last year any mine would be under construction and for most of the construction period, 2 mines would be under development at the same time.

The employment impacts for the construction phase of the high development scenario were

FIGURE 31
TIME PROFILE FOR CONSTRUCTION AND MINE EMPLOYMENT



Source: USDA-Forest Service, 1987.

measured at year 10. With 2 mines being developed and production not yet started, the number of jobs created would total 283 (Table 33). Direct employment in the construction sector would account for about one-half of the total. Other industries that would expand include the nonrecreation-related wholesale trade industry which would increase by 30 due to indirect effects, the motor freight industry which would add 18 jobs, again because of the indirect impacts, and various service industries such as eating and drinking places and hospitals.

TABLE 33
EMPLOYMENT IMPACTS OF ALTERNATIVES B, C, D and E
(High Development Scenario-Construction)

Sector	Change			
	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0
Mining	0	0	0	0
Construction	140	3	1	144
Manufacturing	0	10	3	13
Transportation, Communications, Public Utilities	0	23	2	25
Trade	0	36	18	54
Finance, Insurance, Real Estate	0	8	3	11
Services	0	14	20	34
Government	0	1	1	2
Total Jobs	140	95	48	283

Source: USDA-Forest Service, 1987.

The economic impacts of the production phase for the high development scenario were analyzed at year 24 when all 8 mines would be operating

at one time (Figure 31). The total number of jobs created would be 2,077 with direct effects of 800, indirect effects of 982, and induced effects of 294. The indirect and induced impacts may, however, be overstated, since it takes some period of time (possibly several years in the case of induced impacts) before all of these jobs exist. Because the eight mines would be producing at the same time for only two years, the increase in employment due to indirect and induced impacts would end once the older mines begin to close.

Of the 982 jobs resulting from the indirect effects of the peak mining activity, 269 would be in nonrecreation-related wholesale trade, 54 would be in eating and drinking places, 36 in vehicle repair, 29 in hotels and lodging places, 26 in fabricated metal products manufacturing, and 25 in sawmills and planning mills. The indirect impacts would also be significant in banking and real estate. The induced effects would again be concentrated in the trade and services sectors.

Drilling activity in the high development scenario would result in a direct employment increase of 30, and the indirect and induced effects would add another 30-40 jobs in the six-county area.

One aspect of the Jobs, Economy, and Lifestyle issue relates to the concern that any employment or income increases as a result of mining would be of only temporary duration. Under both the low and high development scenarios of Alternatives B, C, D and E, significant employment and income impacts would not occur until year 7 when construction begins (Figures 30 and 31). Year 25 would be the last year of production under the low development scenario, so, ignoring the reclamation phase, the positive direct and indirect employment and income effects would be maintained for 19 years. The induced impacts from the mine closure may not fully work their way through the analysis area for some time after the shutdown.

Under the high development scenario, the last mine would stop producing after year 38, so the direct impacts would last for 32 years. The negative direct, indirect, and induced employment and income impacts from mine closings would, however, begin in year 26.

Under every scenario of Alternatives B, C, D and E, all jobs created as a result of the exploration, construction or mining activity would ultimately be eliminated. Employment would eventually decline to Alternative A levels.

Income

The income impacts of the different alternatives are presented in Table 35 and Figures 32 and 33. From the standpoint of those sectors most affected by various phases and scenarios of the alternatives, the income effects are generally similar to the employment impacts discussed above. For Alternative A,

TABLE 34
EMPLOYMENT IMPACTS OF ALTERNATIVES B, C, D and E
(High Development Scenario-Production)

Sector	Change			
	Direct	Indirect	Induced	Total
Agriculture	0	2	2	4
Mining	800	32	0	832
Construction	0	63	6	69
Manufacturing	0	129	20	149
Transportation, Communications, Public Utilities	0	88	11	100
Trade	0	289	110	399
Finance, Insurance, Real Estate	0	148	19	167
Services	0	185	122	307
Government	0	46	4	50
Total Jobs	800	982	294	2,077

Source: USDA-Forest Service, 1987.

TABLE 35
INCOME IMPACTS
(Millions of Constant 1985 Dollars)

Sector	Alt. A	Alternatives B,C,D and E			
		Low Scenario		High Scenario	
		Const.	Prod.	Const.	Prod.
Agriculture	0.07	0.01	0.01	0.01	0.10
Mining	0.00	0.00	4.19	0.00	33.58
Construction	0.07	3.95	0.18	7.91	1.53
Manufacturing	1.21	0.19	0.54	0.38	3.69
Transportation, Communications, Pub. Util.	0.29	0.46	0.55	0.91	4.29
Trade	2.07	0.50	1.04	1.01	8.10
Finance, Insurance, Real Estate	0.30	0.46	1.65	0.79	11.81
Services	1.05	0.30	0.85	0.73	7.51
Government	0.14	0.02	0.15	0.04	1.51
Total	5.21	5.89	9.16	11.77	72.11

Note: Numbers may not add due to independent rounding. Income figures for Alternatives B, C, D and E represent income impacts over and above those of Alternative A.

Source: USDA-Forest Service, 1987.

outputs from the study area generate $5.2 million (constant 1985$) in income to the analysis area with the distribution of that

income shown in Figure 32. Recreation-related retail trade, sawmills and planing mills, eating and drinking places, and hotels and lodging places are the industries which experience the greatest income impact from the Alternative A outputs.

Under Alternatives B, C, D and E, the income effects range from $5.9 million per year in the construction phase of the low development scenario to $72.1 million per year at peak production in the high development scenario. As previously mentioned, the indirect and induced effects may be overstated for the production phase of the high development scenario. The construction and mining sectors account for the largest percentage of total income due to the relatively high wages in these industries.

In terms of per capita income, the only appreciable increase would occur under the production phase of the high development scenario and, even then, the analysis area would still be far below the average for Missouri and the United States. Per capita income in the analysis area would increase by a maximum of about 8% or from $600 to $700 per year in the production phase of the high development scenario, while an increase of 1% or less would be expected in the other phases and scenarios of Alternatives B, C, D and E.

The income effects would not, of course, be spread equally across the population, as people hired in the mining and construction industries would earn much more than those finding work in, for example, retail trade. There would also be a segment of the population in the impact area which derives no benefits, employment or income-related, from the mining activity.

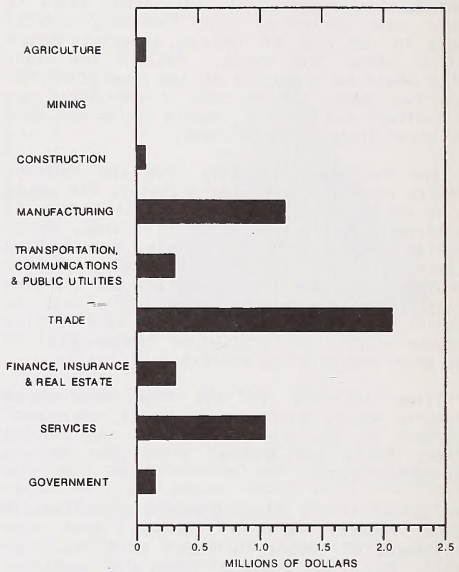
Economic Base

Changes to the economic base of the analysis area would occur when a new industry moves into the region, an existing industrial sector moves out or closes down, or an existing industry expands or contracts at a rate different than other industries in the area.

Alternative A would result in the least change to the impact area's economic base of the six-county area, since it most closely approximates the current situation. The economic base, if measured by the distribution of employment among major industrial sectors would likewise not be substantially altered under Alternatives B, C, D and E.

The most noticeable change to the economic base in Alternatives B through E would be the addition of the lead mining sector. With the exception of some small-scale sand, gravel, and limestone operations, mining does not currently exist in the analysis area. Therefore, the development of just one mine would represent a change even though the change would be quite small. Under the maximum production phase of the high development scenario, mining employment would still only account for only

FIGURE 32
INCOME ATTRIBUTABLE TO STUDY AREA OUTPUTS
(Alternative A)



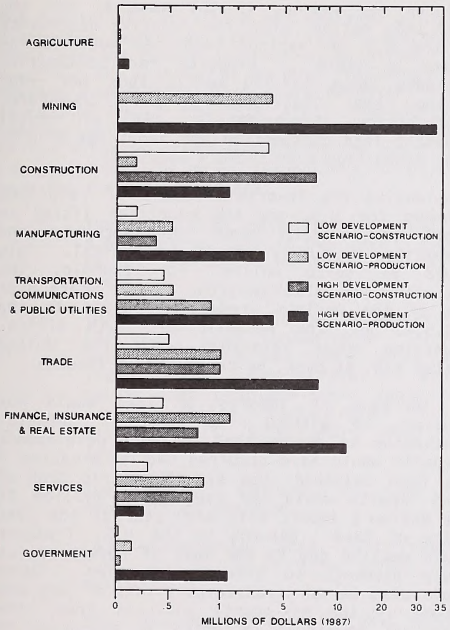
Source: USDA-Forest Service, 1987.

about three percent of the total number of nonagricultural wage and salary jobs in the analysis area. The employment shares of the other major sectors would not vary appreciably from current levels, but individual industries within the major sectors may increase or decrease in relative importance.

Unless the mining activity results in, for example, unacceptable noise pollution or substantial degradation of air or water quality, recreation and tourism in the impact area should not be adversely affected to a significant degree under any alternative or scenario. As discussed in the section on employment effects, there is no sound basis for projecting a decrease in recreation outputs from the Study Area. In fact, recreation demand may even increase because of the higher population and income levels which would have a positive impact on recreation and tourist-related businesses.

Also, persons who prefer to avoid the Study Area due to the mining activity may choose to recreate at a different location within the six-county area. To the extent that this would be the case, total economic impacts may not change, but there could be differences in the geographic distribution of the effects.

FIGURE 33
CHANGE IN INCOME FOR ALTERNATIVES B, C, D AND E
(Constant 1985 Dollars)



Source: USDA-Forest Service, 1987.

Returns to Government

As previously discussed in Chapter Three, the six county analysis area received $428,854 in Fiscal Year 1985 from the 25% fund, and $244,447 of this amount can be attributed to lead mining activity in the Viburnum Trend. Because these funds are distributed on the basis of each county's proportion of acreage within the Mark Twain National Forest and not according to where the revenue-generating activity occurs, the payments to counties depend, not only on the scenario and phase of the alternatives, but also upon what happens to mining activity outside the study area. Under Alternative A, payments to the six counties could drop by the entire $244,447 once the reserves in the Viburnum Trend are depleted. If, however, future discoveries are made outside the Study Area, the mineral-related payments to counties may not decrease at all under Alternative A.

Assuming no production from outside the Study Area, mineral-related payments to counties under the high development scenario of Alternatives B, C, D and E would presumably follow a pattern similar to that experienced as a result of mining activity in the Viburnum Trend. The absolute payment levels could, however, be lower unless there is significant improvement over the 1985 and 1986 base metal prices. Payments to counties under the low development scenario would be a small fraction of their current receipts.

Lead Market

This issue relates to the concern that, in light of current and anticipated future market conditions, potential lead resources in the study area would not be needed and would not be economically mineable. On the other hand, there is a concern that potential lead resources in the study area are needed to assure a stable, secure, long-term supply of lead for the nation. This section presents a discussion of the feasibility and security of supply components of the mining industry issue.

Security of Supply

As discussed in Chapter Three, taking into account probable import and recycling levels, the domestic resources of lead appear more than adequate to accommodate expected cumulative primary demand in the U.S. for at least the next 20 years. Reserves, those resources which could be economically extracted at the time of determination, also should be sufficient until some time beyond the year 2000. The U.S. Bureau of Mines (1985) has estimated that measured and indicated lead reserves in the United States total 21.0 million metric tons of contained lead with 16 million metric tons located in Missouri. Another 4 million metric tons of measured and indicated reserves are in Alaska, where lead would be recovered as a byproduct of zinc and silver production.

In a more recent report (Wharton, 1987), reserves in the Viburnum Trend were computed to be 6.6 million metric tons of contained lead. This estimate was developed from the annual reports of mining companies operating in the Viburnum Trend. Some of the companies included only measured reserves in their annual report, so this figure is not strictly comparable with the Bureau of Mines estimate. Also, the Bureau of Mines included unmined reserves in the Indian Creek and Old Lead Belt deposits in their evaluation. However, even if the Bureau of Mines' estimate of reserves in Missouri was reduced to 6.6 million metric tons, U.S. reserves of lead still appear adequate in the short and intermediate run.

On a worldwide basis, the Bureau of Mines estimated reserves to be 95 million metric tons of contained lead, far in excess of their 68 million metric ton high forecast scenario for cumulative primary demand through the year 2000. Allowing for a decrease in reserves due to lower prices as well as production that has occurred since the estimates were published, reserves still seem sufficient for the next 20 years or more. Also, new discoveries typically offset at least a part of any production-related decreases in reserves. Table 36 shows the distribution of the world's lead reserves.

In addition to adequate reserves, there is also a large stock of old scrap available from which lead can be recovered (Bureau of Mines, 1985). Much of this is in the form of storage batteries which were manufactured in the late 1970's, but which have not been recycled due to the drop in lead demand and the resulting low scrap prices. The question of security of supply, therefore, appears to be most relevant for the period beyond the next 20 years.

The only alternative to which the security of supply issue is pertinent is Alternative A. Under the other alternatives, leasing would be allowed and geologic and economic conditions would determine how much lead, if any, is produced from the study area. The effects of Alternative A on the security issue depend upon the amount of lead foregone by not developing possible reserves in the study area.

TABLE 36
WORLD LEAD RESERVES BY REGION
(million metric tons lead content)

Region	Reserves
North America	36.5
United States	21.0
Canada	12.0
Honduras	0.5
Mexico	3.0
South America	2.5
Peru	2.0
Others	0.5
Europe	28.5
U.S.S.R.	12.0
Yugoslavia	4.0
Bulgaria	3.0
Spain	2.0
Others	7.5
Africa	6.0
Republic of South Africa	4.0
Others	2.0
Asia	5.5
China	2.0
India	2.0
Others	1.5
Australia	16.0
Total	95.0

Source: Bureau of Mines, 1985.

If there are no additional discoveries and domestic lead reserves become depleted, the U.S. would have to rely on imports and secondary production to satisfy demand. If the simplifying assumption is made that imports are equal to the amount of foregone lead production from the Study Area, imports would then total approximately 520,000 metric tons per year under the High Development Scenario. If it is further assumed that the distribution of imports, by source, is the same as for the 1982-1985 period, then the relative dependence of the U.S. on various countries would be as shown in Table 37 (imports for consumption averaged about 157,500 metric tons per year during the 1982-1985 period, therefore, representing approximately 14% of total domestic lead consumption and about 36% of U.S. mine production over these 4 years).

Considering the favorable nature of relations between the U.S. and the countries listed in Table 37, concern about the security and stability of supply should be minimal. This would be quite unlike, for example, the situation for platinum-group metals where over 90% of the world's production occurs in the U.S.S.R. and the Republic of South Africa, countries whose relations with the United States can, at best, be described as tenuous.

An increase in imports of lead would not however, be without its negative impacts. Continuing to assume that the high development scenario would have occurred had Alternative A not been selected, the 520,000 metric tons of lead imports would add about $250 million to the Nation's import bill each year at the 1986 price of lead. Returns to the U.S. Treasury would decline due to the loss of royalties, as would payments to affected counties. There would also be an irretrievable loss of jobs and income in the six-county analysis area, the potential magnitude of which is discussed in the Economic Effects section of this chapter.

If either the exploration or low development scenarios would have otherwise occurred, the negative effects on returns to the U.S. Treasury, jobs, income, and imports attributable to Alternative A would be significantly reduced.

TABLE 37
DISTRIBUTION OF U.S. IMPORTS OF LEAD CONTAINED IN CONCENTRATES AND WROUGHT/UNWROUGHT METAL

Country	Percent
Canada	49
Mexico	21
Peru	13
Australia	6
Honduras	2
Others	9
Total	100

Source: Bureau of Mines, 1987.

Considering estimated reserves, the location of these reserves, the likely sources of U.S. lead imports, and the expected greater emphasis on recycling, the probability of a disruption in the supply of lead appears to be low, even if

Alternative A is selected and domestic reserves are not mined. Nevertheless, there would be a number of disadvantages associated with a greater reliance on imports.

The feasibility of mining was analyzed using a discounted cash flow rate of return approach. There was not enough information on either the quantity or quality of mineral resources to develop a mine plan which would necessarily be representative of the Study Area. Therefore, a hypothetical mine of the type typically found in the Viburnum Trend was used as the model for the analysis. The major assumptions that were made for the evaluation are:

1. The production rate for the mine is 3,630 metric tons (4,000 short tons) of ore per day. The mine life is 15 years.

2. Three products would be recovered in the mill: Lead concentrate: 90,719 metric tons (100,000 short tons) per year. Zinc concentrate: 9,071 metric tons (10,000 short tons) per year. Copper concentrate: 4,536 metric tons (5,000 short tons) per year

3. The metal content of the 3 concentrates would be:

   Lead concentrate: lead (75%); copper (2%); silver (1.65 troy ounces per metric ton)

   Zinc concentrate: zinc (57.5%); silver (13.78 troy ounces per metric ton)

   Copper concentrate: copper (30%)

4. Metal prices are the annual averages for 1986 (expressed in constant 1985 dollars):

   Lead: $ .214/lb
   Zinc: $ .370/lb
   Copper: $ .646/lb
   Silver: $5.26/troy ounce

5. Development and mine and mill plant costs are spread equally over the 4 year construction phase. Mine and mill equipment costs are distributed equally over the last 2 years of the construction phase, and 25% of the equipment would be replaced in year 8.

Operating and capital costs for the hypothetical mine were estimated using the Bureau of Mines' Cost Estimation System. Cost estimates developed from this system are considered to fall within the acceptable limits for a prefeasibility estimate, that is, within + 25% of actual outlays. Table 35 shows the costs that were used in the discounted cash flow analysis.

For comparison purposes, the announced investment costs of Asarco, Incorporated's West Fork Mine was $77 million (Sassos, January 1986). Since the capacity of the West Fork Mine is similar to that of the hypothetical mine, the capital costs used in the discounted cash flow analysis may be understated.

TABLE 38

ESTIMATED OPERATING AND CAPITAL COSTS FOR A HYPOTHETICAL MINE

Type of Cost	Cost (1985$)
Capital:	
Mine	$22.6 million
Mill	24.3 million
Total	$46.9 million
Operating:	
Mine	$ 8.27 per metric ton
Mill	5.47 per metric ton
Total	$13.74 per metric ton

Source: Bureau of Mines Cost Estimation System, 1987.

Using the costs from Table 37 and the assumptions outlined above, the discounted cash flow rate of return for the hypothetical mine was determined to be 12.2%. Whether any company would consider this an acceptable rate of return would depend upon the cost of capital to their firm.

The cost of capital typically varies between companies, so it is impossible to cite a minimum rate of return that would be applicable to all. The Bureau of Mines generally uses a discount rate of 15% in their Minerals Availability Appraisal program which is an indication that a rate of return of 12.2% may be considered inadequate. It must be noted, however, that 1986 prices were used in the analysis, and the 1986 prices for several of the commodities were well below historical averages.

As of July 21, 1987, prices of all four of the metals considered in the analysis were higher than their respective 1986 averages. In constant dollar terms, the increases ranged from about 10% for copper to 80% for lead. Using July 21, 1987 commodity prices, the discounted cash flow rate of return would be well above 15%, even if capital costs were increased by $30 million.

Therefore, assuming a discovery of a deposit having the characteristics previously described, the probability that an economically feasible mine could be developed would appear to be high.

SOCIAL EFFECTS

Lifestyles

Assessing the effects on lifestyles is not easy because people's lifestyles involve many complex relationships which are not directly quantifiable. For purposes of this analysis,

the effects on lifestyles will be assessed based on possible or perceived changes in the patterns of work and leisure, and effects on the overall quality of life.

Lifestyles are often sensitive to change. The level of sensitivity, and whether the change is viewed as positive or negative, depend upon the individual. Any social, economic or environmental changes brought about by a mineral-development project would be felt and perceived differently by different individuals. Some would view such developments as a deterioration in the quality of one's lifestyle due to the impacts on the natural environment, a faster pace of life, and perhaps less friendliness among residents. Others might view such developments as an improvement in one's life due to expanded job opportunities and increased economic security.

The degree of such impacts and people's perceived reactions, however, are difficult to predict, measure or quantify. Table 39 provides some proxy measures of possible lifestyle changes which will be used for purposes of this analysis.

TABLE 39
INDICATORS OF POTENTIAL LIFESTYLE CHANGES

	Alt. A	Alt. B,C,D and E1/	
			Scenario
Indicator		Expl.	High	Low
Employment (jobs)				
Forest Prod.	188	2/	188	188
Construction	na	na	141	283
Production	na	na	265	2,077
Income				
Forest Prod.	$5.2	2/		
Construction	na	na	$5.9	$11.8
Production	na	na	$9.2	72.1
Acres Disturbed	0	30	451	3335

1/ Effects in total are the same for Alternatives B through E. It should be understood that effects are in addition to all other activities shown under Alternative A.
2/ Effects are very small as discussed under the economic effects section.

Source: USDA-Forest Service, 1987.

Under Alternative A, the lifestyles would probably not be disrupted or changed from the existing situation. The management prescriptions and planned outputs of the Forest Plan for this area complement the economic base, provide for continued economic growth and, at the same, time protect and enhance the natural amenities of the impact area. Residents would continue to enjoy a modest income, education, and urban opportunities, supplemented by the abundant natural resources and rural environment.

The effects on lifestyles could potentially be the greatest under Alternative B, since 100 percent of the study area would be available for leasing. The effects could be potentially less under Alternatives C, D, and E, since a lower percentage of the study area is available for leasing.

The exploration scenario would not likely disrupt existing lifestyles. Exploration activities would not noticeably increase population, income or employment levels. Depending upon the extent of exploration, some disturbances in the physical and natural environments would occur. These disturbances would consist of drilling activities on 30 acres for a period of 6 years. Although such disturbances would generally not be noticeable to most individuals, the mere presence of the drilling activity could reduce the quality of life for some people, because the land character and setting would be altered. The effects would be the same for Alternatives B, C, D and E, since exploration activities are not restricted.

The low development scenario would have greater effects on lifestyles than the exploration scenario. However, relative to the existing population and economic base of the analysis area, the effects would probably be insignificant.

From Table 39, this scenario would provide 141 new jobs and generate $5.9 million dollars of new income during the construction phase, and 265 new jobs and $9.2 million dollars of new income during the mine operation phase. The employment opportunities would be primarily in the construction, trade and services sectors of the economy. The majority of jobs would probably be filled by area residents. The jobs would span a variety of occupations, but would be either of an operator, fabricator, laborer, machine trade or service-type occupation. There would be a few professional and managerial type positions also, but these jobs would usually be filled by individuals from outside of the area.

Those individuals who are directly or indirectly employed as a result of mineral development activities would probably experience a change in their lifestyle. The extent of the change would depend upon their past circumstances. If they were previously unemployed, they would enjoy benefits of greater job security and family income. If they were already employed, but changed jobs and/or occupations as a result of mineral-development activities, they might enjoy greater income benefits and acquire additional occupational skills. In either case, the standard of living for these people would probably improve.

How people value the natural environment would determine whether such benefits would offset any potentially negative effects on the natural landscape. The low-development scenario would impact over 400 acres, and could change the land character and its setting. Additionally, there might be more congestion, noise and litter on the streets and highways due to

increased populations in local towns. If these changes are perceived negatively, the job and income benefits may not offset such changes.

If they are not perceived negatively, such economic benefits may offset the changes in the landscape. Again, such changes and how they are perceived depend upon the individual. Since each person is different, the tradeoffs made on a person's lifestyle are also made differently.

Similarly, those individuals who are not directly or indirectly employed as a result of mineral-development activities, might also experience a change in their lifestyle. Again, the extent of change would depend upon the particular individual.

For instance, those individuals with a strong appreciation for the natural environment and its amenities may perceive a disruption in the natural landscape negatively, and experience a reduction in their quality of life. Because these individuals would not have employment related to the mineral development, such negative effects on their lifestyle would not be offset by any positive economic benefits.

In another way, mineral-development activities and the increased demands placed on business and community services may have some local inflationary effects. In these areas, the cost of living may rise temporarily. Those individuals who do not receive any economic benefits (higher income or wages) to offset these costs could be adversely affected.

The high development scenario would have the greatest effects on people's lifestyles. Again from Table IV-4, this scenario could provide 283 new jobs and generate $11.8 million dollars of new income during the construction phase, and 2,077 new jobs and $72.1 million dollars of new income during the mine-operation phase. The acres that could be potentially disturbed would be around 3,300. The effects would be similar to those discussed under the low-development scenario, except more pronounced.

Although the effects on lifestyles from the closure of mining operations are difficult to assess, it would probably lessen economic security. Those workers and their families who lose their jobs, whether directly or indirectly related to mine closure, could suffer economic hardship. The length of the hardship would depend upon whether they could return to former employment, seek retirement benefits, or pursue other job opportunities. Local businesses that expanded or began as a result of mining operations could also face long-term economic hardship.

Attitudes, Beliefs and Values

Based on a review of the public comments, the attitudes and sentiments that people held toward hardrock-mineral development activities were mixed. The attitudes and concerns were expressed by individuals, the mining industry, professional societies, elected officials and other organizations advocating specific agendas and views. Chapter I discusses and summarizes the scoping process and the more salient issues and concerns.

An analysis of the comments indicated there were primarily three viewpoints toward mineral-development activities in the study area. The first view maintained strong sentiments toward protecting and preserving the natural environment. This view maintains that such developments would threaten water quality and the scenic and recreational values of the area. Individuals and organizations holding this view would probably view any mineral-development activities as harmful, with negative impacts on the quality of the natural environment. Those holding this viewpoint would be least adversely affected by Alternative A.

A second viewpoint is that economic development, jobs and the economy are of the greatest importance, and should be encouraged whenever opportunities arise. This view maintains that many environmental effects from mining are temporary, and that mining is vital to the well-being of both the Nation and Missouri. The individuals and organizations holding this view would perceive mineral-development activities as positive and beneficial to the study area. Those maintaining this view would be positively affected by Alternatives B and E.

A third view is less polarized, and bridges the other two viewpoints. This view would support mineral-development activities, but only if the natural environment could be protected. Those holding this view would look upon mineral-development activities as being positive, but would carefully scrutinize any environmental impacts. These individuals would probably be least affected by Alternatives C and D.

Social organization means the institutions and organizations in which people are associated within a community. It is usually described in terms of four dimensions: community stability and cooperation; social institutions; housing; and community services. The effects of mineral activities on social organization are largely a function of in-migration and the time frames during which such changes occur. Again, the effects are difficult to assess due to the existing, complex interrelationships of how people live and work together.

Community stability is the ability of a community to accommodate and manage change. Additionally, it deals with the degree of unity and cooperation that exists among people within a community. When changes occur that prevent or interfere with a community's ability to solve problems or meet the needs of its residents, the stability and cooperation of a community is challenged.

As previously discussed, the demographic effects on the six-county area change very little under any alternative or scenario.

Provided the following assumptions hold true, there would be little adverse effect on social stability or patterns of social interaction if (1) most people employed as a direct or indirect result of mineral activities are from the six-county area, (2) newcomers are distributed relatively evenly throughout the area, and (3) mineral development activities take place over a long time horizons.

In the event that population increases were concentrated in only a few localities of, say, Shannon and Oregon Counties, then social stability and interaction could be disrupted. The extent of the disruption would depend upon newcomers' attitudes and their ability to integrate within existing communities. Social unrest could increase or communications could become more formalized if the newcomers' attitudes were different or they failed to integrate themselves within the local community. Because of the higher level of in-migration, these kinds of effects would more likely occur under the high-development scenario.

Given that in-migration is assumed to be low relative to the existing population under any alternative, it is unlikely that the voting and individual political activities of newcomers could affect local political life and elections. It is not likely that newcomers would develop themselves as a separate group and compete for power and status in the community unless they experienced problems of integrating with local residents. If problems occurred, then they may establish new community groups and compete for power to meet their needs. It is not known how this might disrupt community stability or cooperation.

Social institutions are sensitive to change and, if impacted, usually affect the economy and lifestyles simultaneously. The family, church, schools and local business and government are types of social institutions that can be impacted as a result of a major project or program. The family is one of the more sensitive institutions, and would be the most likely affected by mineral-development activities. As discussed in Chapter III, the family is highly valued in the analysis area.

Any changes to this institution could disrupt local community stability. The family would be most readily impacted where members are directly or indirectly employed as a result of mineral-development activities. In this case, the family would gain employment security, and possibly a higher family income. Family members not employed as a result of mineral activities would not receive such benefits.

Because the influx of newcomers would not likely be high relative to the existing population, the relative economic position of most families would not change. It is not known how mineral activities would impact the family in terms of problems such as alcoholism or anxiety, divorce, separation or remarriage, young adults dropping out of school to take high-paying jobs, or drug abuse.

Mineral-development activities would have no effect on the civil rights of residents within the analysis area under any alternative or scenario.

The churches of the analysis area would not likely be affected under any alternative or scenario.

Similarly, the elementary and secondary public schools of the analysis area would not likely be affected under any alternative or scenario. Because most schools have experienced a decline in student enrollment since 1980, and have relatively low student/teacher ratios, most schools could accommodate increases in enrollment due to in-migration without affecting the quality of education. Since the newcomers' families would probably be distributed throughout the area, the effect of higher student enrollments on any one school would be very small. If, however, the newcomers' families were not evenly distributed, but were concentrated in a specific area perhaps some local schools could be more heavily impacted.

Local business and government would be affected to different degrees under each of the alternatives or scenarios. Under Alternative A, local business and government would not likely be affected or changed. Under Alternatives B, C, D and E it would depend upon the scenario.

The exploration scenario would be similar to Alternative A, and have little to no effect on business. The low and high-development scenarios, however, could establish a new primary base industry, namely lead mining. The establishment of this industry within the analysis area could create new secondary businesses or new expansions of existing businesses. Based on a review of the larger communities within the area, most have some level of comprehensive planning or available industrial sites to locate future businesses.

Local businesses directly or indirectly related to mineral-development activities could be affected in any number of ways. Some businesses might lose trained employees to other higher-paying mining jobs. Some smaller businesses may be displaced by similar but larger businesses (e.g., department stores or grocery stores). In some instances, local businesses may experience busier conditions, causing customer relations to become more formal and less courteous. These effects would be the greatest under the high-development scenario.

Local county and town governments could be affected because additional services such as water and sewer, law enforcement, fire protection and street maintenance would have to be provided to meet rising demand for such services. The effects would be greatest under the high-development scenario, and less for the low-development scenario.

Housing is another dimension of social organization. As discussed in Chapter III, the

types and standards of housing are highly variable within the analysis area. The vacancy rate on homes that are either for sale or for rent has averaged around 10 percent (about 4,400 homes) for the impact area. The rental vacancy rate has averaged around 11 percent (about 1,100 homes). These rates are fairly consistent across all counties. Pressures on the demand for housing are more immediately created as a result of the influx of newcomers but, additionally, personal housing preferences.

As shown in Tables 27 and 28, the expected increase of in-migration and new households is low relative to the existing population and number of vacant homes. Although it is not known whether newcomers would prefer or consider the existing vacant homes as suitable to meet their needs, the existing stock of homes seems adequate to accommodate any in-migrating labor force within the analysis area.

The greatest demands on housing would occur under the high-development scenario. Under this scenario, it is likely that around 40 new houses would be needed during the construction phase, and around 190 would be needed during the mine-operation phase. This would mean that anywhere from 1 to 4 percent of the existing vacant homes that are either for sale or for rent could potentially be used.

The impacts of the low-development scenario would be much less, with the exploration scenario and Alternative A having little or no effect on housing. Because in-migration would be low, it is likely that home prices, rental rates and land values would not be affected under any alternative or scenario.

Community services such as municipal water supplies, wastewater treatment facilities, solid-waste disposal, law enforcement, and medical facilities are also an important element of social organization. Impacts to these services could occur as a result of in-migration from mineral-development activities. Workers and their families would move into the area, establish homes, and exert increased demands upon these services.

Based on a review of the community services within the analysis area, it is not likely that the mineral-development activities would affect these services under any alternative or scenario. Presently, municipal water supplies are utilized to around 30 to 35 percent of capacity, and wastewater treatment facilities at around 45 to 50 percent of capacity. These facilities could accommodate the increased service demands from any in-migration.

Solid-waste disposal is available in the larger communities. Although some communities are presently experiencing problems in identifying new landfills and in selecting alternate disposal methods for the future, because the population changes as a result of mining operations would be relatively small, it is unlikely that the solid-waste disposal services would be impacted.

Although there is a high priority placed on safety in mine/mill operations, accidents and injuries do occur. Similarly, with the need for more routine medical care, more workers and families in the area accidents will probably increase. Injured and ill individuals would require the assistance and care of physicians in the analysis area. The percent increase in such accidents is not known, but the existing medical facilities and personnel would likely be able to accommodate any increased demands for such services. The local community fire departments, which are generally staffed by volunteers, would be adequately equipped to protect residences of newcomers.

With the influx of newcomers, traffic accidents and crime such as assault, robbery, burglary and arson could possibly increase. Such increases are difficult to assess, since much depends upon the type of newcomers and their attitudes toward local community residents and services. It is not known what percent increase in traffic accidents or criminal activity would occur. Under the high-development scenario it is likely that additional law enforcement officers would be required, even though the exact number is not known. Under the low-development and exploration scenarios and Alternative A, the existing law enforcement services would probably be adequate to handle any increase in such problems.

Mitigation Measures

The effects on social organization from any mineral-development activities could be lessened depending upon how well the applicants of hardrock-mineral leases cooperate with, and assist, local community people, businesses and governing officials. For example, some financial assistance to communities could help defray costs for needed community services due to increased demand. In another way, the training and use of workers within the impact area would reduce population in-migration and possibly utilize unemployed persons with existing skills.

Effects After Mitigation

Cooperation would also lessen impacts on lifestyles and, perhaps, more positively influence the attitudes and perceptions people have toward development activities.

LAND CHARACTER

A review of public comments indicated there was considerable interest regarding the effects of mineral development activities on the land character of the study area. Some of the greatest concerns people had were that mineral activities could threaten or destroy scenic and recreational values and natural or historical sites. The land's scenic and recreational values and the variety of experiences it provides are important reasons why some people have chosen either to permanently reside in the area or to visit.

Although difficult to define, land character has to do with the relationships people have with the land. Land character relates to many physical, biological, visual and social factors. The relatively rugged terrain, natural springs, water quality, presence of cultural and historical sites and unique plant and animal communities are some of the primary factors influencing local people's lifestyles and quality of life. Further, changes in any of these factors are perceived differently by people. In other words, the land character perceived by one person may not be the same as that perceived by another due to differences in values, preferences and attitudes.

Although it is difficult to assess, changes in the character of the land will be based on two kinds of effects. These consist of (1) changes in the landscape and (2) changes in land-use patterns. Changes in the landscape may result from such activities as road construction, powerline installation, mine/mill facilities or mine waste-disposal sites. Land use patterns may be affected by increased populations or user pressures, increased traffic and noise and increased demand for facilities and services. Although these kinds of effects can be measured quantitatively, such changes will be perceived differently by various people. Therefore, changes in land character can be described, while the significance and other qualitative effects of such changes may vary depending upon each individual.

The discussion describes the effects by scenario first, then describes the effects between alternatives.

Changes To The Landscape

Under the exploration scenario, changes to the landscape would probably occur, but would have an insignificant effect on the way land character is perceived. Changes to the landscape would be minimal since temporary drill site locations and roads would impact only 30 acres of the study area (Table 5), over a six year period. Roads would be constructed to the minimum standard to permit access and facilities rehabitation. Although drill-site clearing and operation of drill rigs could cause temporary noise and visual disturbances, revegetation and closure of these sites would eliminate long-term impacts.

Under the low development scenario, there would be greater changes to the landscape and hence, more significant effects on land character than under the exploration scenario. However, the disturbed acreage would be more concentrated than under the dispersed activities of the exploration scenario.

A number of different landscape changes could occur under the low development scenario. Access roads would be required for the mine/mill, vent shafts, drill sites and water disposal sites. A powerline corridor to the mine/mill would be very evident on the landscape. A tailings impoundment would similarly create visual impacts of the surrounding landscape. If water quality were affected by mine/mill operations, algal blooms and noxious odors could potentially occur in receiving streams and waters of the tailings impoundment.

Since it is unknown exactly where a mine/mill facility might be located, the significance of such landscape changes on land character are difficult to assess. If the facility were located on a site which minimized impacts to the visual landscape and current use patterns, the effect on land character would be less. For any other situation the effects would be greater.

The high development scenario would result in the greatest effects on the landscape and thus the most significant effects on land character. Because this scenario would be similar to the Viburnum Trend development the effects would be of greater magnitude and more pronounced than those anticipated to result from the low development scenario.

The probable changes to the landscape would be greatest under Alternative B, since hardrock mineral leases and subsequent mineral activities would be permitted throughout the study area. The effects would be somewhat less under Alternative C thru E. The least potential for effects on landscape changes would be under Alternative C. This alternative would not allow powerlines or tailings impoundments to be constructed in visually sensitive areas, comprising a significant portion of the study area (Figures 16 and 17).

Mitigation Measures

There are a number of ways in which changes to the landscape could be reduced or mitigated. These mitigation measures could be common to all alternatives. Mitigation measures described in all physical and biological sections of Chapter Four - particularly Water, Visual Resources, Areas of National Significance, and Special Areas - would apply to landscape changes.

Effects After Mitigation

The application of mitigation measures would reduce landscape changes but would not eliminate them.

Changes In Land Use Patterns

Under the exploration scenario, changes in general land-use patterns would probably be unlikely, since drilling activities are not 'new' to the area but have occurred in the study area for many years.

However, because there are differences between individuals, some people in the vicinity of an operating rig might be disturbed by the noise and could be surprised to find drill rigs in the study area. This could diminish the quality of the recreation experience for some individuals, especially if it occurred near the Eleven Point Scenic River, the Ozark or Blue

Ridge Trails, or other areas where users expect more primitive or semi-primitive recreational experiences.

The low development scenario would affect land use patterns to a greater extent than exploration. An increase in traffic would result in higher volumes as well as a greater variety of vehicles. For those individuals who now value the study area for its peaceful scenic characteristics the additional traffic and roads may cause some people to value the study area less. These individuals may choose to adjust their use patterns within the study area, or travel to other areas. The presence of powerlines or mine facility buildings may be disturbing to those people who choose to visit the area or reside in the area because of its distinctly rural or 'undeveloped' character. Some residents and tourists might choose to seek other areas for recreational pursuits.

Because the location of a mine/mill facility is unknown at this time, the significance of such land use patterns on the way land character is perceived is difficult to assess. A large part of the study area would be unaffected while another part could be significantly affected. For example, if facilities tended to concentrate in the area north and west of the Eleven Point River, the increased traffic, noise, activity and facilities could detract from river users' experience and change their perceptions of the river character.

Similarly, if facilities were concentrated north of the Irish Wilderness, the wilderness values may be compromised. Wherever facilities are located, the perception of some persons could cause them to change their use pattern to avoid areas of mineral development and activity.

The effects under the high development scenario on land character would be similar to the low development scenario except be of a much greater magnitude.

Similar to landscape changes, the greatest potential effects on land use patterns would occur under Alternative B, while the least potential for effects would occur under Alternative C. The effects under other alternatives would be somewhere between these two extremes.

Mitigation Measures

There are a number of ways in which changes in land use patterns can be mitigated. All mitigation measures identified for physical and biological sections of Chapter Four - particularly Visual, Recreation, and Wildlife - would apply to changes in land use patterns.

Encourage the company to provide bussing or carpools for mine workers. This would reduce the amount of traffic on roads in the study area. It would be somewhat reduce noise, congestion and air pollution in the more pristine environment.

Effects After Mitigation

Although application of these mitigation measures would reduce changes in land-use patterns they would not be eliminated.

SUMMARY OF MITIGATING MEASURES

INTRODUCTION

Many potential effects of development can be either reduced or eliminated through the use of mitigating measures. Mitigating measures for mineral leasing in the study area have been identified and evaluated for each issue, concern or resource to ensure that activities authorized under hardrock mineral leases are consistent with the purposes for which Mark Twain National Forest lands were acquired and are being administered.

The Council on Environmental Quality (CEQ) defines mitigation as: (a) avoiding the impact by not taking the action or parts of the action; (b) minimizing the impact by limiting the degree or magnitude of an action; (c) rectifying the impact by repairing, rehab- ilitating, or restoring the affected area; (d) reducing or eliminating the impact over time by preservation and maintenance during the life of the project; and (e) compensating by replacing or providing substitute resources or environments. The mitigation measures discussed below are consistent with CEQ regulations and are based on Bureau policies and regulations, Forest Service policies and Plan standards, and the extensive experience the two agencies have had with similar activities in the Viburnum Trend.

Once the mitigation measures have been identified, the authority must be assured to require that mitigation. In most cases, the basic hardrock lease terms provide authority to require compliance with mitigation measures. However, those mitigation measures not included in the basic lease terms, stipulations must be included as lease stipulations or as conditions of approval to the operating plan.

Stipulations modify the basic lease right to develop and produce mineral resources. The purpose of stipulations is to protect resources and avoid conflicts. Mitigations included as stipulations would then be part of the lease and must be accepted by the lessee at the time of lease issuance.

Conditions of approval are measures designed to mitigate the effects of actual drilling and operations. Such conditions are site-specific measures included in a approved plan of operations subsequent to lease issuance. Because the requirement for such measures is provided by existing Bureau operating regulations (43 CFR 3590) and Section 6 of the lease instrument, conditions of approval need not be attached to the lease but rather are included as specific requirements in plans of operation. Although an attempt has been made to

identify and evaluate all conditions of approval, additional measures based on site-specific requirements or new technologies may be established in the future as plans of operation are reviewed and approved.

MITIGATION MEASURES

(1) Design and locate facilities to reduce disturbance and facilitate reclamation.

Stipulations:

- No surface occupancy within wetlands; 5 acres surrounding any cave entrance; within 1000 feet of known Threatened and Endangered Species hab- itat; Tupelo Gum Pond, Falling Spring; Turners Mill; Horseshoe Bend; Bliss Spring; cultural resource sites; within 100 feet of fens, springs, seeps and reparian area;

- No exploration activities within designated recreation areas and the Eleven Point River Zone on weekends and holidays between March and Thanksgiving Day

- No development activities within 500 feet of designated recreation areas and within the Eleven Point River Zone

- No tailings impoundments, powerlines, mine/mill sites or haulroads will be permitted within the areas identified on the attached map. (These locations vary by alternative. The exact areas will depend on the alternative selected. The map will be attached at the time of lease consent.)

Conditions of Approval:

- Cultural Resource and Threatened and Endangered Species surveys are required before final approval of disturbance, construction or use.

- Permanent structures will be permitted in flood plains only if no other locations are available.

- Avoid erosive soils and steep slopes.

- Edges of openings must conform to natural terrain.

- Use plants of varying heights.

- Remove trees and slash from planned impoundments.

- Bury powerlines where possible.

- Use complimentary colors, natural material and natural screening to make facilities blend into environment.

- Design and construct powerlines to prevent raptor electrocution.

- Develop a vegetation management plan to maintain habitat quality within powerline corridors.

(2) Design and locate facilities to allow natural surface and groundwater flows.

This mitigation is a condition of approval.

(3) Reclamation plans will include provisions for immediate stabilization and meeting Forest Plan objectives.

Conditions of Approval:

- Reclaim disturbed areas as soon as possible.

- Reshape to ensure stable drainage and natural control.

- Use plant species suited to the site that will accomplish Forest Service management objectives.

(4) Control wind blown contaminants.

Conditions of approval:

- Cover stock piles and vehicles hauling concentrate.

- Pave sites and wash down areas to collect fugitive dust for recycling.

(5) Control point source pollutants.

Conditions of approval:

- Construct vents so fumes are filtered and vented vertically.

- On site disposal of drilling effluents.

(6) Tailing disposal method must meet Missouri Department of Natural Resources "no discharge" requirement.

(7) Use noise abatement techniques and practices.

Conditions of Approval:

- Vent fans will be either underground or muffled.

(8) Impoundment Operation and Maintenance plan.

Conditions of Approval:

- The plan must meet all State and Federal regulations.

- The plan must include an emergency preparedness response and contingency plan.

- The impoundment(s) must be staffed 24 hours a day and maintained in pertuity (including strikes and work stoppages).

- Minimize amount of water retained in tailings impoundment.

(9) Lessee must develop and implement an education and environmental awareness program.

ALTERNATIVE TAILINGS DISPOSAL METHODS

Several methods of tailings disposal other than Viburnum-type tailings impoundments are used elsewhere in the world. These include (PED Co Environmental, Inc., 1984):

1. Ponds lined with various materials to prevent or minimize seepage;

2. Placing tailings back into mined-out portions of the mine (called "stope backfilling");

3. Burying the tailings in excavated pits (called "below grade disposal");

4. Mounding the tailings up into large above-ground piles (the "thickened-discharge" method);

5. Using tailings off-site for construction materials and/or agricultural lime.

Additional tailings disposal possibilities for the study area include transporting the ore elsewhere for milling, or transporting the mill tailings elsewhere for disposal.

This section describes and evaluates the various tailings disposal methods in comparison to Viburnum-type tailings impoundments. The alternative methods are discussed here to evaluate the potential effects anticipated to result from their use. This evaluation also identifies those methods which could reduce or eliminate the effects of tailings impoundments as well as identifying those effects not caused by the use of traditional impoundments. The actual use of such alternative methods will be dependent upon factors such as the size and location of the ore body, surface characteris- tics and hydrogeologic characteristics of the site.

IMPOUNDMENT LINERS

Impoundment liner materials include native clays available at or near the site, swelling clays like Bentonite, soil cements, petroleum derivatives, plastic sheeting, elastomers (stretchable plastic) and rubber sheeting (PED Co Environmental, Inc., 1984). Because the uncontrolled escape of mill effluent through tailings pond bottoms is thought to be a significant danger in the study area, lining the ponds with impermeable materials is an attractive idea.

All liner materials require a dependable foundation upon which to lie. Although liners can be effective at retarding diffuse seepage through homogeneous soil materials, they lack the strength to bridge over voids beneath them. Should voids develop beneath the liners, the weight of the tailings and water above would easily rupture the liners and render them ineffective. Once ruptured, they would be virtually impossible to repair.

Soil cements, clays including Bentonite, and petroleum derivatives need only minimal foundation preparation prior to laying. Liner sheets of plastic, elastomer and rubber, on the other hand, require a smooth, compact foundation free of sharp objects like rocks which might puncture them either during installation or later as the weight of the pond contents presses down on them.

Sheet liners also have the problems of weakness and possible leakage in the seams where the sheets are joined, and of tearing during installation or later if the foundation should settle differentially. Again, breaks, tears and leaks could not be repaired after the liners were covered with tailings and water.

Some soil cements and all clays are not subject to chemical or biological degradation, and would last for extremely long periods of time. Plastic, rubber and similar materials, however, do degrade with time. The useful life of most artificial liners currently available is 30 to 40 years (PED Co Environmental, Inc., 1984).

Even if all of these liner problems could be overcome, lining tailings ponds is very expensive. In an assessment of pond-liner technology prepared for EPA (1984), PED Co Environmental, Inc. concluded that, "Whereas liners can be used effectively in relatively small impoundments, their use in the very large impoundments typical of the mining industry . . . has not been demonstrated and does not appear feasible. The size of these impoundments makes the cost of liner installation a controlling factor."

Lining Viburnum-type tailings impoundments and probably would help retard leakage from them, at least during the liners' useful life.

The potential environmental effects of lined ponds include all of those for unlined ponds. If ponds were lined with native clays, there might be additional effects from excavating a large area to obtain the clays. The borrow area might be a source of sediment, probably would destroy soil productivity, vegetation and wildlife habitat, and would be visually unsightly.

STOPE BACKFILLING

Placing tailings back into worked-out portions of the mine has a number of attractive features. Coarse tailings are most easily placed back underground, and one mine in the Viburnum Trend is currently doing that. Fine tailings must be substantially dewatered on the surface before they can be backfilled, a more difficult but not impossible task.

Initially, tailings would have to be stored temporarily above ground until space became available below ground. Throughout most of a mine's active life, all tailings could be disposed of in the mine. Because they are less dense than the native rock, however, not all of

the tailings would fit back underground at the mine's closure. Some would have to be left on the surface. The amount of surface disruption would, however, be far less than if all of the tailings were disposed of in a traditional tailings impoundment.

With stope backfilling, a minewater clarification pond would still be required, and perhaps a small tailings impoundment. Possible environmental effects associated with these facilities would be the same as for conventional Viburnum-type facilities, except the magnitude of effects associated with the tailings impoundment be considerably less.

There would be one possible effect with stope backfilling that does not exist in a conventional Viburnum-type operation. Tailings placed back in the mine undoubtedly would contain metal sulfides and carbonates, and trace amounts of milling reagents. The metals would remain as relatively harmless particulates in the mine, but milling reagents not similarly bound up in the alkaline environment could spread from the mine in groundwater. The relatively impermeable Derby-Doerun and Davis Formations overhead would probably prevent significant contamination of more productive aquifers above, but wells penetrating below the Davis Formation could be tainted. The nearest known such well is at Ellington, 30 miles to the northeast, and well beyond any danger.

BELOW GRADE DISPOSAL

The practice of burying tailings in excavated pits presently is unique to the uranium mining industry, where it is considered necessary to reduce the probability of tailings escape by erosion or dam failure (PED Co Environmental, Inc., 1984). It would be extremely costly in the study area, where metal mining would be by deep shafts rather than shallow open-pit methods.

The only potential advantage of open-pit tailings disposal in the study area would be that the possibility for tailings dam failure would be eliminated. Pits likely would affect larger areas than tailings ponds, although covering them with the excavated dirt when full probably would provide a better growth medium for revegetation than bare or clay-capped tailings. Very large mounds equal in volume to the amount of tailings buried would significantly change the topography and visual landscape. Erosion of the excavated material which had been stockpiled for later replacement could cause stream sedimentation. Vegetation and wildlife habitat would be temporarily destroyed. Seepage, subsidence and collapse in the pit bottoms would be potential dangers to groundwater quality.

THICKENED DISCHARGE

The thickened discharge method partially dewaters the tailings and discharges them onto a sloping, cone-shaped pile similar in appearance to the large "chat piles" in the Old Lead Belt. Unlike the Old Lead Belt piles, however, eroded particles and liquid drainage would be contained around the piles' circumference to prevent their escape off-site. Chemically contaminated water draining from the pile would be collected and either recycled back through the concentration mill or, less likely, purified for discharge off-site (PED Co Environmental, Inc., 1984).

The thickened discharge method has some attractive features compared to conventional tailings impoundment. Tailings piles could be located on study area uplands which, although there are frequent exceptions, generally "leak" less surface water to the groundwater system than area valleys in which tailings impoundment would probably be build.

A small pond would still be needed to hold mill recycling water, and dikes or ditches would be needed to contain the tailings pile and capture drainage from it.

The thickened discharge method may require less land than the conventional tailings impoundment. This would reduce the potential loss of soil productivity, vegetation and wildlife habitat. The tailings could be reclaimed in sections to further reduce total area affected. However, windblown dust could be a problem, and depending upon surrounding topography these tailings may be visible for miles. Successful reclamation could help these piles blend into the surrounding landscape.

OFF-SITE UTILIZATION

Potential off-site uses for tailings include highway embankment fill, sub-base material for concrete and asphalt highways, anti-skid snow-control material for highways, aggregate for concrete and asphalt paving mixes, and agricultural lime.

The cost of transporting tailings to utilization sites generally makes them economically competitive with alternative materials only very near the concentration mill. Thus, this disposal method could handle only a very small portion of the tailings produced. There are additional objections spreading the heavy metals contained in the tailings across the off-site landscape rather than keeping them confined.

EXPORTING ORE AND TAILINGS

Conceivably, ore could be transported out of the study area for processing or tailings could be transported for disposal. Highway transport would be prohibitively expensive. Rail transport might be possible, but many miles of track would have to be constructed. Waterborne slurry transported through a pipeline probably would be most feasible. Any pipeline would have to be a closed-circuit system, carrying the ore/ tailings slurry out of the area, then returning the water to the mine/mill area for reuse in a new slurry mixture.

The economic feasibility of transporting ore and/or tailings out of the study area is unknown. Certainly, it would relieve a number of environmental concerns, particularly those about surface water and groundwater contamination by heavy metals and milling reagents. Sedimentation would still be a possibility during railroad or pipeline construction, and the landscape's visual attractiveness could be diminished by either.

UNAVOIDABLE ADVERSE EFFECTS

In any alternative, there are some actions which would occur and would result in adverse effects to one or more resources. These actions may be partially mitigated and the adverse effects would not necessarily be unacceptable, but would be unavoidable.

The alternatives differ only in the locations where activities could occur. Therefore, the effects would be essentially the same where the action occurred; but the chance of activities being located near sensitive areas would be different between alternatives.

There would be no unavoidable adverse impacts to physical or biological resources under Alternative A. However, the mineral industry would not be permitted to develop or produce in the study area.

Of the Alternatives allowing mineral development, the chance for mineral activities to be located near sensitive areas would be highest under Alternative B, somewhat less under Alternatives D and E, and lowest under Alternative C.

The chance of unavoidable adverse impacts occurring would be greatest under the high development scenario and least under the exploration scenario.

SOILS

There would be some soil erosion from sites cleared of vegetation for facility construction or other uses. Some fugitive dust would escape off-site and be deposited on soil. The extent of the adverse effect would depend on the amount of soil eroded or dust which escaped.

Paved areas and tailings impoundments would reduce soil productivity on those areas.

WATER RESOURCES

It is possible that mining activity would alter water flows or levels in specific areas. The extent and severity of the adverse effects caused by changes in water flow or level are unknown.

Although the risk of release of tailings or mill waste into the environment is very small, if such a release occurred, water quality would be adversely affected. The magnitude of the effect would depend on many factors.

WETLANDS

If facilities were located adjacent to wetlands, or within a short distance, fugitive dust containing traces of heavy metals and milling reagent could enter the wetland. The adverse effects of this type of contamination are unknown.

If tailings or mill effluents were released into wetlands, wetland values would be adversely affected to some degree.

FLOODPLAINS

Facilities located in floodplains would cause temporary disruption of the recreation, visual, quiet, and forest production values of the occupied area. Impoundments located in floodplains would cause a long-term loss of floodplain values.

AIR QUALITY

Vehicles, vent shafts, and mills would emit exhaust and some fugitive dust would escape from sites. These sources would meet all Federal and State Air quality standards and would not cause an unacceptable reduction in air quality.

VISUAL RESOURCES

Vegetation would be cleared for openings, corridors, structures and new structures would be constructed. Above ground tailings disposal sites would be obviously different than the surrounding landscape. These activities would cause variations in the landscape which would be objectionable to some people.

CULTURAL RESOURCES

There would be no unavoidable adverse effects on cultural resource sites since field surveys would establish their presence prior to work being initiated and no mineral activity would be permitted where cultural resource sites were located.

AREAS OF NATIONAL SIGNIFICANCE

There would be interaction between persons visiting these areas and mineral activities, which could be disturbing to some visitors. If tailings or mill effluents were released, water quality of the Eleven Point National scenic River or Ozark National Scenic Riverways could be decreased.

SPECIAL AREAS

Visitors to these areas would come in contact with evidences of mineral activities. This would be disturbing to some people.

RECREATION

More vehicle traffic, visual changes, and noise associated with mineral activities would be objectionable to some recreation users.

PLANTS OF SPECIAL CONCERN

There would be no unavoidable adverse effects to plants of special concern, unless there were a release of tailings or other mill wastes into the waters of the area. If that happened, plants of special concern might be located where they would pick up (through water or soil) heavy metals or reagents. The effect to the plant would depend in part on what volume of materials was incorporated into the plant, the time the plant was exposed to the materials, the general health of the plant at the time of exposure, and other environmental factors. The chance of this happening would be very small.

TERRESTRIAL WILDLIFE

Habitats would be changed where vegetation was cleared for mineral activities or facilities. During clearing, some non-mobile animals would be killed and nests, dens, or other cover destroyed. This would not cause unacceptable decreases in any species across the study area. Noise from mineral activities would temporarily disturb some animals.

Tailings or milling effluents, if released into study area waters, would be available for many terrestrial wildlife species. The effect on individual animals would depend on many factors. The chance of a release occurring would be very small and there would be even less probability that such a release would cause long term decreases in any species population.

AQUATIC WILDLIFE

Some sediment would reach area waters, but probably not in large enough amounts to cause more than temporary effects to aquatic species. If tailings or mill effluents were released into area waters, some species population could be decreased or destroyed. The risk of such a release happening is very low.

LAND CHARACTER

Land character would be changed to some degree by visual changes, an increase in road mileage and traffic, and the addition of structures and large powerlines.

LIFESTYLE

There would be no unavoidable adverse effects on jobs or economy. The lifestyle of some area residents could change. Some people would perceive these changes to be negative.

LEAD MARKET

Under Alternative A, the mining industry would not be permitted to develop or produce Federal minerals in the study area.

Alternative B would permit mineral development in most of the study area, with the exception of the Eleven Point National Scenic River zone and other small, scattered areas where no surface occupancy would be allowed.

Alternative C would limit mineral industry operations to the north and east parts of the study area.

Alternatives D and E would allow development activities in about half the study area. Activities would not be allowed in corridors along sensitive travelways and near high-use areas.

CUMULATIVE IMPACTS

The cumulative effects of implementing the alternatives was determined by adding the effects of Forest Plan activities to the effects of mineral activities permitted by each of the alternatives. The Forest Plan activities for the study area are summarized in the beginning of this Chapter and in the Forest Plan (pages IV-50 to IV-57). Cumulative impacts assume that high development scenario would occur.

The greatest potential cumulative effect would occur if tailings impoundments failed. This sudden or long term leakage of tailings could choke the groundwater system, alter surface and groundwater flows, disrupt cave life and contaminate springs. Although there are no Forest Plan activities proposed that could have as dramatic an effect, Forest Plan activities do increase the risk of water quality degradation from increased sedimentation. In combination, the tailings and sediment could reduce the recreational value of receiving streams and lower the quality of aquatic wildlife habitat. The magnitude would depend upon the proximity of the mineral and Forest Plan activities to receiving streams.

Alternative B would have the greatest potential cumulative impacts on the visual resource, special area, areas of national significance, recreation and land character. Mineral activities permitted throughout the study area, in addition to planned forest activities may significantly reduce the value and uses of these resources. These resources would be protected from most of these impacts under Alternative C and to a lesser extent under Alternatives D and E. Forest activities would increase the risk of loss of these values but

the risk is slight if Forest Plan standards are met.

Mineral activities, in addition to Forest Plan activities, would affect the social/economic environment. Total employment and income would increase, but the impacts would vary industry. There would be an increase in population and a greater demand on public services. Some people look forward to the accelerated growth; others see it as an unacceptable change.

Assuming that there are no tailings disposal problems, the greatest cumulative effect of mineral and Forest Plan activities, is the potential change to land character. In combination, these activities would accelerate the "opening up" of the area. There would be more roads, powerlines and clearings; there would be more demand on services, resources and space.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

MINERAL RESOURCES

It is not known at this time whether or not the study area contains economically mineable quantities of lead, zinc and associated metals. However, if a lease or leases are issued and if mineable reserves do exist, the level of development and production will be dependent upon the actual volume of economically recoverable reserves discovered. Those resources discovered and economically producible would be irreversibly committed to development.

SOILS

The establishment of long-term developments (project life) including paved roads, transmission corridors, mine/mill sites and tailings/mine water clarification impoundments would constitute an irreversible commitment of soil productivity. Short-term developments such as temporary roads and drill sites will be used for a period of one to five years and reclaimed immediately after use. Activities on these areas will not result in an irreversible commitment of the soil resources.

WATER RESOURCES

The obstruction or alteration of groundwater flows which could result from the construction of mine and air-vent shafts could constitute an irreversible commitment of the water resources within or adjacent to the study area. This would be the case in the event springs and artesian wells ceased to flow and wells dried-up as a result of changes in the groundwater regime.

The contamination of surface and groundwater resources resulting from the use of herbicides and the accidental release of drilling effluents, sanitary sewage, milling reagents, petroleum products and tailings could constitute an irretrievable resource commitment in the event water quality was degraded for a long period of time. Due to the self-cleansing ability of water resources in the study area, however, such a loss in unlikely to occur.

WETLANDS

The alteration of groundwater levels adjacent to wetlands or the diversion of natural surface waterflows away from wetlands would constitute the irretrievable commitment of water resources.

The contamination of wetlands resulting from the accidental release of toxic materials could also result in an irretrievable commitment.

FLOODPLAINS

The long-term loss of floodplains resulting from the development of tailings and water clarification impoundments would constitute an irreversible commitment of the resource and its associated values.

VISUAL RESOURCES

The development of long-term facilities including permanent roads, pipeline and transmission corridors, impoundments and mine/mill structures would result in the irreversible commitment of the area's visual resources. It is anticipated that areas disturbed by roads, pipeline and transmission corridors and mine/mill structures could be re-contoured immediately after use. It would not be possible, however, to re-contour areas occupied by impoundments. Temporary facilities typically associated with drilling activities will be reclaimed immediately after use.

WILDLIFE

Although unlikely, chronic leakage or catastrophic collapse of an impoundment would release contaminants into surface and/or groundwater resulting in the possible loss of wildlife habitat. If such an effect occurs, an undeterminable amount of habitat including that for Federal and State protected species would constitute an irreversible commitment.

Areas disturbed by the construction of long-term facilities such as permanent roads, pipeline and transmission corridors, mine/mill structures and tailings and mine water clarification impoundments would constitute an irreversible commitment of resources and values previously used as wildlife habitat.

LAND CHARACTER

Anticipated changes to the landscape patterns and land uses of the area could accelerate the on-going gradual change of land character resulting from the encroachment of developed areas and rise in area population. This accelerated change could result in an irreversible trend away from the area's natural environment and traditional values.

SHORT-TERM USES VERSES LONG-TERM PRODUCTIVITY

Short term mineral uses under high development could cause long term changes to the study area. Over 3,000 acres of National Forest land would be used for impoundments, structures, roads, powerlines, vent shafts and drillsites. With the exception of the ventshafts and drill-sites most of these improvements would probably remain beyond the life of the mines. They would become a part of the area's infra-structure.

Approximately 800 acres of land used for dill sites, temporary roads and vent shafts could be returned to their pre-mining condition with no long term loss of productivity. Land covered by tailings or used for mine-water clarification (approximately 2,160 acres) could probably not be returned to their pre-mining condition as productive upland forests. How-ever, the land could be reclaimed to provide other uses. For example one tailings pile in the Old Lead Belt is being used for off-road recreation vehicle parks. Another pile is being used as a sanitary land fill.

Paved roads, some powerlines and mine/mill sites (about 415 acres) would probably not be removed. Therefore, this land would be permanently unavailable for other uses and long term productivity would be lost.

Whether or not mill-waste tailings would constitute a long-term threat to the water resource would depend on whether they were stored on the surface, such as in a tailings impoundment, or were placed back in worked-out portions of the mine(s). Underground disposal would reduce the possibility of long-term effects; surface storage would maintain the possibility forever.

The greatest possibility for long-term effects of tailings on the water resource would be from collapse of a tailings impoundment bottom into underlying voids.

Such a collapse could be very difficult, if not impossible, to plug at reasonable cost.

Tailings impoundment failure which changed water quality could also have long term effects on adjacent wetlands, recreation, areas of national significance, special areas, well water and terrestrial, aquatic and cave wildlife.

In addition to long term effects on the physical and biological environment, mining would have long term effects on the social and economic environment. During operations there would be increases in employment and population, and a greater demand on community services. This will accelerate the growth of some communities and hasten changes in lifestyle from rural/forest product-based economy to a more urban/mineral-based economy.

There will be additional long term social/economic impacts when mining ceases. There would be a sudden loss of jobs and revenues. This could strain the community structure. The magnitude would depend upon whether or not unemployed miners could return to former employment, seek retirement benefits or pursue other job opportunities. Local business that expanded or began as a result of mining operations could also face long term economic hardship.

Not leasing these minerals would defer production of the mineral resource. This may affect long term domestic production.

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COOPERATING AGENCIES

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U.S. Fish and Wildlife Service
National Park Service
U.S. Army Corps of Engineers
U.S. Geological Survey

CONSULTATION

Bureau of Mines
Environmental Protection Agency
Missouri Department of Natural Resources
Tom Aley, Private Consultant
Harold Meyers and John Carter, Doe Run Corporation
Missouri Department of Economic Development

MEETINGS

Numerous EIS Team meetings were conducted during preparation of the Draft environmental impact statement. In addition, three meetings were held with the cooperating agencies and the Missouri Department of Natural Resources. Further, the Jefferson City meeting was held during the EIS scoping process and included representatives of numerous State and Federal agencies and the mining industry.

December 10, 1986 — Jefferson City, Missouri: Meeting to discuss the preparation of the Draft EIS and identify concerns with respect to mining activities.

January 22, 1987 — Rolla, Missouri: Meeting to review the results of the EIS scoping process and to provide a list of issues and concerns.

June 25, 1987 — Rolla, Missouri: Meeting to review progress of the EIS and to distribute Chapters One, Two, Three and Four for comment.

FACT FINDING TRIPS

On June 24, 1987, the EIS Team toured the study area with Tom Aley (private consultant) and James A. Burris (Missouri, DNR). The purpose of the tour was to discus the study area's karst terrain and water system, and to discuss potential problems with conventional tailings disposal techniques.

On September 2, 1987 the EIS Team toured the Viburnum Trend mining district and the Old Lead Belt near Bonne Terre, Missouri. The tour was conducted by Harold Meyers and John Carter of Doe Run Corporation. James A Burris (Missouri DNR) and Willis C. Self (USDA-Forest Service - Engineer) also attended. The purpose of the tour was to review past and current tailings disposal methods and to discuss the use of various tailings disposal methods in the study area.

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APPENDIX 1

Glossary

Absorb - the penetration of one substance into or through another.

Activity pattern - a series of actions made by an undisturbed animal and repeated in a certain period of time.

Acute toxicity - any poisonous effect produced by a single short-term exposure that results in severe biological harm or death.

Adsorb - the adherence of a thin film of liquid or gas to the surface of a solid substance.

Age-class - a term to indicate the relative age of organisms; animals produced during the same year are said to be of the same age-class as are trees produced in the same decade.

Algae - simple, chlorophyll-containing aquatic plants (many microscopic).

Algal bloom - the proliferation of living algae on the surface of lakes, streams, or ponds; blooms are stimulated by phosphate enrichment.

Alluvium - material such as sand or silt deposited by a stream.

Analysis area - the delineated area subject to significant economic and social impacts from proposed mining activities in the study area; larger than the study area.

Animal unit month (AUM) - the quantity of forage required by one mature (1,000 lbs.)cow or the equivalent for one month.

Annuals - plants that complete their life cycle in one year or less.

Arthropods - invertebrate animals that have jointed body and limbs, usually with a chitinous shell which is molted at intervals.

Bachelor cave - a cave used by male and non-reproductive female bats during the summer.

Background - see Sensitivity Levels

Benthic organisms - animals or plants occurring on the bottom of a body of water.

Best management practices - a practice or combination of practices that are determined by a State or designated area-wide planning agency to be the most effective and practicable (including technological, economic, and institutional considerations) means of controlling point and non-point pollutants at levels compatible with environmental quality goals.

Biological Integrity - the combination of numbers of plant and animal species and number of individuals which in total make up a functioning community.

Biodegrade - to significantly breakdown the physical and/or chemical structure of a substance by the action of microorganisms.

Biological assessment - a documented evaluation of the potential effects of a proposed Federal action on Federally listed endangered, threatened, or candidate species and their habitat.

Biological oxygen demand (BOD) - the dissolved oxygen required to decompose organic matter in water. BOD is used to measure pollution since heavy waste loads create a high demand for oxygen.

Biologically inert - unable to be concentrated or used by living organisms.

Board foot - an amount of wood equivalent to a piece 12 inches by 12 inches by 1 inch.

Brine - warm to hot fluids generally composed of water with high concentrations of dissolved saols, usually associated with deep or restricted sedimentary basin.

Buffer zone - an area or strip surrounding another specific area, in part or entirely, to protect the inner area from disturbances by influences from the outside.

Calcareous meadow - an area of grasses and perennial forbs growing on soil containing large amounts of calcium carbonate or calcium

Carbonates - compounds formed with carbonic acid.

Carrion - the putrifying dead body of an animal.

Cash flow - reported net income and expenditures of a corporation plus amounts charged off for depreciation, depletion, amortization, and extraordinary charges to reserves (bookkeeping deductions not paid out in cash).

Castings - undigestible remains of animals eaten by predators, usually regurgitated rather than passing through the digestive system

Chronic toxicity - a condition of poisonousness, marked by a long duration, that produces an adverse effect on organisms. The end result can be death, although the usual effects are sublethal, such as inhibiting reproduction or reducing growth. The effects are reflected by changes in productivity and population structure of the community.

Clearcut - an area from which all trees have been removed by cutting.

Climax community - the highest ecological development of a plant community capable of sustaining itself under the prevailing climate and soil conditions.

Collectors - substances which attract particles of a certain metal to aid in separating metal from ore in the milling process.

Colluvium - material such as sand, silt, or clay deposited by downslope movement.

Colonial bats - bats which roost together, sometimes in great numbers

Common variety mineral - earth materials which generally have no special economic value, such as sand and gravel.

Community stability - the capacity of a community to absorb and cope with change without major hardship to institutions or groups within the community.

Concentrate - the valuable material separated from ore.

Constant dollar value - a monetary value which compensates for the effects of inflation.

Copepods - minute freshwater and marine crustaceans.

Corridor - a linear strip of land identified for the present or future location of transportation of utility rights-of-way within its boundaries (36 CFR 219.3).

Craton - a portion of continental crust that has remained stable for a long period of time.

Crustacean - aquatic arthropods including lobsters, shrimp, crabs, wood lice, water fleas and barnacles.

Cyclone - a device which removes excess water from crushed ore by spinning at high speed (RPM); a type of centrifuge.

Demographic impact - relates to the size, distribution and density of a population.

Detritus - particulate material, organic or inorganic, formed by the decomposition of dead animals, or matter worn from rocks by mechanical means.

Developed recreation - recreation that requires facilities that result in concentrated use of an area. Examples are campgrounds and ski areas. Facilities might include: roads, parking lots, picnic tables, toilets, drinking water, ski lifts, and buildings.

Developed recreation site - a distinctly defined area where facilities are developed to serve concentrated public use, e.g., campgrounds, picnic areas, and swimming areas.

Dewatering - the expulsion of fluids by hydrostatic pressure from deeply buried strata of sedimentary basins.

Diligency requirements - regulations which ensure that mineral deposits are produced (mined) in a timely, orderly, and efficient manner.

Direct economic impact - the impact on the initial sector experiencing a change in final demand.

Discounted cash flow rate of return - the rate of return that makes the present worth of a cash flow from an investment equal to the present worth of all investments.

Dispersed recreation - in contrast to developed recreation sites, dispersed recreation areas are the lands and waters under Forest Service jurisdiction which are not developed for intensive recreation use. Dispersed areas include general undeveloped areas roads, trails, and water areas not treated as developed sites.

Diversity - the distribution and abundance of different plant and animal communities and species within an area.

Drilling fluids - liquids which keep mud from collecting on drilling equipment, reduce friction, and stabilize clay or shale formations.

Dye traces - a method of determining groundwater flow direction by injecting dye at one place and checking previously placed charcoal packets to see where the dye emerges.

Employment - labor input into a production process, measured in the number of person-years or jobs. A person-year is 2,000 working hours (equals 50 weeks) by one person working year long or by several persons working seasonally.

Economic impact - the change, positive or negative, in economic conditions including distribution and stability of employment and income in affected local, regional, and national economies, which directly or indirectly results from an activity, project, or program.

Existing Visual Conditions (EVC) - six terms have been defined to measure the physical landscape in terms of its deviation from its natural appearance. The terms range from EVC I, no noticeable difference in the physical landscape, to EVC VI, a drastic and glaring disturbance of the natural appearance.

Fen - low land covered wholly or partly with water throughout the year.

Foreground - see Sensitivity levels.

Fragmentation of habitat - creating so many different habitat types in one area that none are high-quality and many species find it difficult to meet their needs within that area.

Guano - bat droppings.

Hardness - a condition of water, caused by dissolved salts of calcium, magnesium, and iron (such as bicarbonates, carbonates, sulfates, chlorides, and nitrates).

Identified resources - mineral resources whose location, grade, quality, and quantity are known or estimated from specific geologic evidence.

Income - employee compensation, profits, rents, and other payments to households.

Indirect economic impact - the impact on industries which provide inputs to the initial sector experiencing a change in final demand (e.g., the impact on the electric utility industry from a change in mine production).

Induced economic impact - the effect which results from employees and business owners spending their income within the impact area.

In-migrate - to move into or come to live in a region or community.

Insoluble compounds - compounds which cannot be dissolved in liquid, or which are soluble only with difficulty or to a slight degree.

Interior forest species - animal species which need large areas of contiguous woodland to thrive.

Intermittent stream - a stream, or portion of a stream, that flows only in direct response to rainfall. It receives little or no water from springs and no long-continued supply from melting snow or other sources. It is dry for a large part of the year, ordinarily for more than three months.

Irish Wilderness Excluded Lands - an area on the Doniphan Ranger District of approximately 1,040 acres set aside by Congress from the Irish Wilderness that permits mineral exploration.

Leachate - a solution derived by the percolation of a fluid (solvent) through a permeable medium containing soluble elements.

Lifestyle - the characteristic way people live, indicated by consumption patterns, and work, leisure, and other activities.

Lithic scatters - a widely-spread, typically superficial in depth, concentration of waste material resulting from the manufacture of arrowheads and other stone tools.

Maximum Modification - see Visual Quality Objective.

MG/L - Milligrams per liter, a unit of measure showing the number of milligrams of one substance contained in one liter of some other substance.

Middleground - see Sensitivity Levels.

Mill effluents - waste products from the milling process.

Millionth-intensity-depth - the depth at which the light which penetrates is reduced to one-millionth of its intensity at the surface.

Mine dewatering - pumping of excess water from a mine; the water enters from the surrounding rock.

Mineralization - the process by which mineral concentrations are formed; or, a potentially economic mineral concentration.

Modification - see Visual Quality Objective

Mucking - removing waste rock (gangue) from mined ore.

Mussel - a freshwater shellfish.

National Wild and Scenic River System - rivers with outstanding remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values designated by Congress under the Wild and Scenic Rivers Act.

No surface occupancy - a condition which prohibits any activity which uses the surface of a particular area.

Organic debris - small particles of decomposing plants or animals.

Organic enrichment - the addition of large amounts of organic matter to a system (usually aquatic).

Out-migrate - to move away or out of an area or community.

Ozark National Scenic Riverways (ONSR) - a 134 mile stretch of the Current and Twin Fork Rivers designated for special management by the Congress in 1964.

pH - a scale from 1-14 to measure acidity, with 7 being neutral, numbers less than 7 increasing in acidity and numbers greater than 7 increasing in alkalinity.

Partial Retention - see Visual Quality Objective

Parts-per-billion - the ratio of units of a substance in air or a liquid to one billion units of medium.

Parts-per-million - the ratio of units of a substance in air or a liquid to one million units of medium.

Payment in lieu of taxes (PILT) - payments to local or State governments based on ownership of Federal land and not directly dependent on production of outputs or receipt sharing. Specifically, they include payments made under the Payments in Lieu of Taxes Act of 1976 by U.S. Department of the Interior.

Perennials - plants that normally live three or more years.

Persons-at-one-time (PAOT) - a recreation term indicating the maximum number of people that a facility is designed to serve at one time.

Photosynthesis - the manufacture by plants of carbohydrates and oxygen from carbon dioxide and water in the presence of chlorophyll, using sunlight as an energy source.

Pioneers - a plant or animal capable of invading barren sites and persisting there; pioneers are then replaced by other, more exacting, species as succession proceeds.

Preservation - see Visual Quality Objective

Primary demand - demand for a metal obtained from ore rather than from scrap.

Primitive - see Recreation Opportunity Spectrum

Reagent - any substance used to produce a chemical reaction.

Recreation Opportunity Spectrum (ROS) - a system of classifying the range of recreational experiences, opportunities, and settings available on a National Forest. Classifications include: (1) Primitive (P), (2) Semi-primitive Nonmotorized (SPNM), (3) Semi-primitive Motorized (SPM), (4) Roaded natural (RN), (5) Rural (R), and (6) Urban (U). Primitive - an essentially unmodified natural environment of a fairly large size. Interaction between users is very low and evidence of other users is minimal. The area is managed to be essentially free from evidence of human-induced restrictions and controls. Motorized use within the area is not permitted. Semi-Primitive Nonmotorized - a predominantly natural or natural-appearing environment of moderate-to-large size. Interaction between users is low, but there is often evidence of other users. The area is managed in such a way that minimum on-site controls and restrictions are subtle, but may be present. Motorized use is not permitted. Roaded Natural - a predominantly natural appearing environment with moderate evidence of man. Such evidence usually harmonizes with the natural environment. Interaction between users may be low to moderate, but with evidence of other users prevalent. Resource modification and utilization practices are evident, but harmonize with the natural environment. Conventional motorized use is provided for in construction standards and design of facilities. Rural - a substantially modified natural environment. Sights and sounds of man are evident. Renewable resource modification and utilization practices enhance specific recreation activities or provide soil and vegetative cover protection. Interaction between users is often moderate to high. A considerable number of facilities are designed for use by a large number of people.

Facilities are often provided for special activities. Moderate densities are provided far away from developed sites. Facilities are intensified motorized use and parking are available.

Real dollar value - a monetary value which compensates for the effects of inflation.

Recreation visitor day - a unit for measuring recreation use which total 12 visitor hours. It may consist of one person for 12 hours, 12 persons for one hour, or any equivalent combination of continuous or intermittent recreation use by individuals or groups.

Reserve base - that part of an identified mineral resource that meets specified minimum physical and chemical criteria related to current mining and production practices, including those for grade, quality, thickness, and depth.

Reserves - that part of the mineral reserve base which could be economically extracted or produced at the time of determination. The term "reserves" need not signify that extraction facilities are in place and operative. Indicated - reserves whose quantity and grade and/or quality are computed from information similar to that used for measured resources, but the sites for inspection, sampling, and measurement are farther apart or are otherwise less adequately spaced. The degree of assurance, although lower than that for measured resources, is high enough to assume continuity between points of observation. Measured - reserves whose quantity are computed from dimensions revealed in outcrops, trenches, workings, or drill holes with grade and (or) quality are computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are spaced so closely and the geologic character is so well defined that size, shape, depth, and mineral content of the resource are well established.

Retention - see Visual Quality Objective

Road density - the measure of the degree to which a length of road occupies a given land area: e.g., one mile of road within a square mile.

Roaded - Natural - see Recreation Opportunity Spectrum.

Rookeries - the breeding or nesting place of a group of birds; in this case, herons.

Rural - see Recreation Opportunity Spectrum.

Saturation - the state of being the most concentrated solution that can persist in the presence of an excess of the dissolved substance.

Scaling - Removal of loose rock and debris from the roof and walls of a mine passage.

Scenario - a model, or design; an environment; a system.

Seasonal restriction - a prohibition against some activity during a certain time period; for example during nesting or hibernating seasons.

Selective maintenance - maintaining an area in low-growing vegetation by selectively killing only those plants which are taller than a set height, or likely to grow taller than that before the next maintenance period.

Semi-Primitive Nonmotorized - see Recreation Opportunity Spectrum.

Sensitivity level - a particular measure of viewer interest in the scenic qualities of the landscape; 1-most sensitive, 2-sensitive, and 3-less sensitive.

Level 1

A. Roads and trails (hiking/horse riding) with National or Regional importance, including designated scenic roads, i.e., Glade Top Trail, Ozark Trail.

B. Primarily, all Interstate, U. S. Highways (Federal primary system which includes principal and secondary arterials) and State numbered roads (principal collectors). Roads that are paved with high design and construction standards and/or primary connector between collector roads.

C. Roads and trails providing primary access to Level 1 Use Areas.

D. Water bodies with National and Regional (Ozark Highlands) importance, i.e., Eleven Point National Scenic River, Council Bluff Lake, Table Rock Lake, etc.

E. Water bodies that are floatable and fishable at least 10 months of the year, and receive high to moderate recreation-oriented use.

Level 2

A. Primarily, all State lettered principal and secondary collectors, all-weather County and Forest Service System roads with observed moderate to high recreation-oriented use and moderate non-recreational use.

B. Usually all-weather paved (can be gravel surface) and usually carries through traffic (not dead-end).

C. Roads and trails providing access to Level 2 Use Areas.

D. All developed trails not designated Level 1.

E. Relatively large perennial springs that are not developed that receive moderate recreation use.

F. Water bodies that are floatable approximately two months of the year (water levels fluctuate moderately with seasons). Fishing and other water enjoyment activities may occur all year. Receive moderate use.

Level 3

A. Primitive County, Forest Service and private, soil and/or gravel surfaced (two-wheel track) roads. Usually no through traffic. Low recreation-oriented use and high non-recreational use.

B. Water bodies that are only periodically floatable and no developed public access; i.e., intermittent streams, small farm and wildlife ponds. Receives low recreation-oriented use.

Foreground (fg) - the detailed landscape found between 0 and 3/8 of a mile from the viewer. Middleground (mg) - the area between foreground and background in the landscape. The area located 3/8 mile to 4 miles from the viewer. Background (bg) - the distant part of a landscape located from 4 miles to infinity from the viewer.

Social impact - the change, positive or negative, in social and cultural conditions that directly or indirectly results from an activity, project, or program.

Social institution - a significant practice, relationship, or organization in a society or culture, such as: the family, the economy, work, government, education and religion.

Social organization - the structure of a society described in terms of institutions, community cohesion, and community stability.

Special Areas - a variety of legislatively or administratively designated areas, about which the public or management have concerns for the protection of unusual environmental, recreational, cultural, and historic resources, or for scientific and educational studies. When this term is used in analysis area identifiers, it includes the Eleven Point National Scenic River, Irish Wilderness, Sinkin Experimental Forest, designated areas, developed recreation sites, lakes, and areas which are candidates for special area designation. National Natural Landmark - an area which represents an important example of the nation's natural ecological or geological history. Natural Area - a physical and biological unit in as near a natural condition as possible which exemplifies typical or unique vegetation and associated biotic, soil, geologic, and aquatic features. The unit is maintained in a natural condition by allowing physical and biological processes to operate, usually without direct human intervention (Backman and Quintas 1972).

Substrate - the base on which an organism lives.

Sulfides - a compound of sulfur.

Taxa - the name applied to a certain group of organisms which are presumed to be related in some way.

Ton metric - 2,204.6 pounds.

Ton short - 2,000 pounds.

Troy ounce - 31.1 grams.

25% fund - the 25% of gross receipts from National Forest System lands distributed to counties in order to compensate them for the immunity from property taxation of those lands.

Unemployment - term referring to individuals not employed but actively seeking employment.

Viburnum Trend - an area of numerous lead and related ore bodies in the vicinity of Viburnum, Missouri. This Trend extends for approximately 30 miles and ranges in width from a few hundred yards to more than two miles. It is the premier lead-producing area in the United States.

Visual Management System (VMS) - the Forest Service system to classify, inventory and manage its visual resources. Variety class - a particular level of visual variety or diversity of landscape character, described as Distinctive (Class A), Common (Class B), or Minimal (Class C). Distinctive - an unusual or outstanding landscape variety that stands out from the common features. Common - the prevalent, usual or widespread landscape variety. It also refers to ordinary or undistinguished visual variety. Minimal - little or no visual variety in the landscape; monotonous or below average compared to the common features.

Visual quality objective (VQO) - a desired level of excellence based on physical and sociological characteristics of an area. It refers to degree of acceptable alteration of the characteristic landscape. Preservation (P) - a visual quality objective that provides for ecological change only. Retention (R) - a visual quality objective which in general means man's activities are not evident to the casual forest visitor. Partial Retention (PR) - a visual quality objective which in general means man's activities may be evident, but must remain subordinate to the characteristic landscape. Modification (M) - a visual quality objective meaning man's activity may dominate the characteristic landscape but must, at the same time, utilize naturally established form, line, color, and texture. It should appear as a natural occurrence when viewed in foreground or middleground. Maximum Modification (MM) - a visual quality objective meaning man's activity may dominate the characteristic landscape, but should appear as a natural occurrence when viewed as background.

Visual resource - the composite of visible terrain, geologic features, water features, vegetation, cultural effects,and land uses that typify and influence the visual appeal of an area.

Visual Variety Class - a particular level of diversity of landscape character, described as: Distinctive (Class A), Common (Class B), or Minimal (Class C).

Wild and Scenic River Act - an Act passed in 1968 which declared that it is a policy of the United States that certain selected rivers of the nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations. The Act established a National Wild and Scenic Rivers System. The Eleven Point National Scenic River was one of the original components of the system.

Wildlife and fish user day (WFUD) - wildlife and fish use (e.g., hunting, fishing) which totals 12 hours. It may consist of one person for 12 hours, 12 persons for one hour, or any equivalent combination of

continuous or intermittent wildlife and fish use by individuals or groups.

Woods roads - a dirt road maintained by use.

APPENDIX 2
HARDROCK MINERAL LEASING PROCESS ON THE MARK TWAIN NATIONAL FOREST

The Bureau of Land Management has primary responsibility for managing Federal minerals beneath the Mark Twain National Forest. This involves administering the exploration for and development of Federal minerals by private industry. The Forest Service has primary responsibility for administering the surface resources. Among other things, this includes developing mineral permit and lease terms to ensure mineral activities do not compromise the uses and values of surface resources. The Bureau cannot issue a permit or lease without the consent of the Forest Service. Together, the Bureau and the Forest Service evaluate permit and lease applications and plans of operation to ensure the wise use of Federal minerals and the protection of surface resources.

The Federal leasing Regulations (43 CFR 3560) provide for the issuance of prospecting permits, preference right leases, competitive leases, fringe acreage leases and lease modifications. These are briefly described below (Sec. 3560.1):

(a) "Prospecting permits" allow the permittee to explore for deposits for hardrock minerals.

(b) "Preference right leases" are issued to holders of prospecting permits who demonstrate the discovery of a valuable deposit of a hardrock mineral(s) under the permit.

(c) "Competitive leases" are issued for known deposits of hardrock minerals and allow the lessee to mine the deposit.

(d) "Fringe acreage leases" are issued noncompetitively for known deposits of hardrock minerals adjacent to existing mines on non-Federal lands which can only be mined as part of the existing mining operations.

(e) "Lease modifications" are used to add known deposits of hardrock minerals to an adjacent Federal lease which contains an existing mine provided the deposits can only be mined as part of the existing mining operations.

In most cases, exploration and development of hardrock minerals on the Mark Twain National Forest is a two stage process involving prospecting permits and preference right leases. A prospecting permit grants the permittee the exclusive right to prospect and explore the permit area to determine the existence of a valuable deposit of the mineral(s) for which the permit was issued. The primary term of the permit is for two years with the possibility of a four year extension. The permittee may remove only such material as is necessary to demonstrate the existence of a valuable mineral deposit. Discovery of a valuable deposit entitles the permittee to apply for a preference right lease. Such a lease authorizes, in accordance with its terms and conditions, the mining of the hardrock mineral(s) including associated minerals for which the lease is issued. The step-by-stepprocess of permitting and leasing is shown in Figures 2A and 2B.

Prospecting Permit

The prospecting permit process begins with the submission of an application (Form 3510-1, Figure 2C). The Bureau requests a title report, environmental analysis, permit stipulations and consent from the Forest Service. Based on findings of the environmental analysis, stipulations are designed to protect public safety, prevent environmental damage and protect surface resources. Areas of no surface occupancy, restricted access or seasonal occupancy are identified by the Forest Service and included as lease stipulations. Concurrent with the request to the Forest Service, the Bureau prepares a geologic report either determining the existence of a workable mineral deposit that should be offered for competitive lease or recommended for additional prospecting.

If the Forest Service provides consent and the Bureau recommends prospecting, the applicant is requested to acknowledge the stipulations, submit a bond and file a pre-permit exploration plan. The applicant is required to submit a surety or personal bond to ensure against default of the permit terms and stipulations (Sec. 3562.7). A pre-permit exploration plan describes the activities which have been proposed to determine the existence or workability of the mineral deposit (Sec. 3562.3-3). Once the requested information is received, the Bureau issues the prospecting permit.

Before the permittee can begin any surface disturbing activities, a site-specific exploration plan must be submitted to the Bureau. The plan is reviewed and all areas of potential surface disturbance are inspected. When the plan is approved by the Forest Service and Bureau, the permittee is allowed to begin exploration activities. The permittee is required to keep the Forest Service and Bureau informed of the progress of operations. Both the Bureau and Forest Service conduct periodic site inspections. When exploration is completed, all disturbed areas are reclaimed to the satisfaction of the Forest Service. The bond is released only after the Forest Service and Bureau are satisfied that reclamation is complete and all conditions of the permit have been met.

Preference Right Lease

Subsequent to exploration activities, the permittee may submit a preference right lease application (Form 3520.7, Figure 2D) to the Bureau (43 CFR Subpart 3563). The Forest Service and Bureau review the application, prepare an environmental analysis and identify

the need for any lease stipulations (43 CFR 3563.2-2). In addition, the Bureau evaluates the geologic data resulting from exploration and the anticipated costs of operations including lease stipulations and determines whether or not the applicant has discovered a valuable mineral deposit (43 CFR 3563.2-1). If a valuable discovery has been made, the Forest Service and Bureau review the application, prepare an environmental analysis and identify the need for any stipulations (43 CFR 3563.2-2). If the Forest Service consents to lease issuance, the applicant is required toacknowledge any stipulations and submit a bond. The lease is issued for a primary term of 20 years with a right for renewals in increments of 10 year periods provided specific requirements have been met.

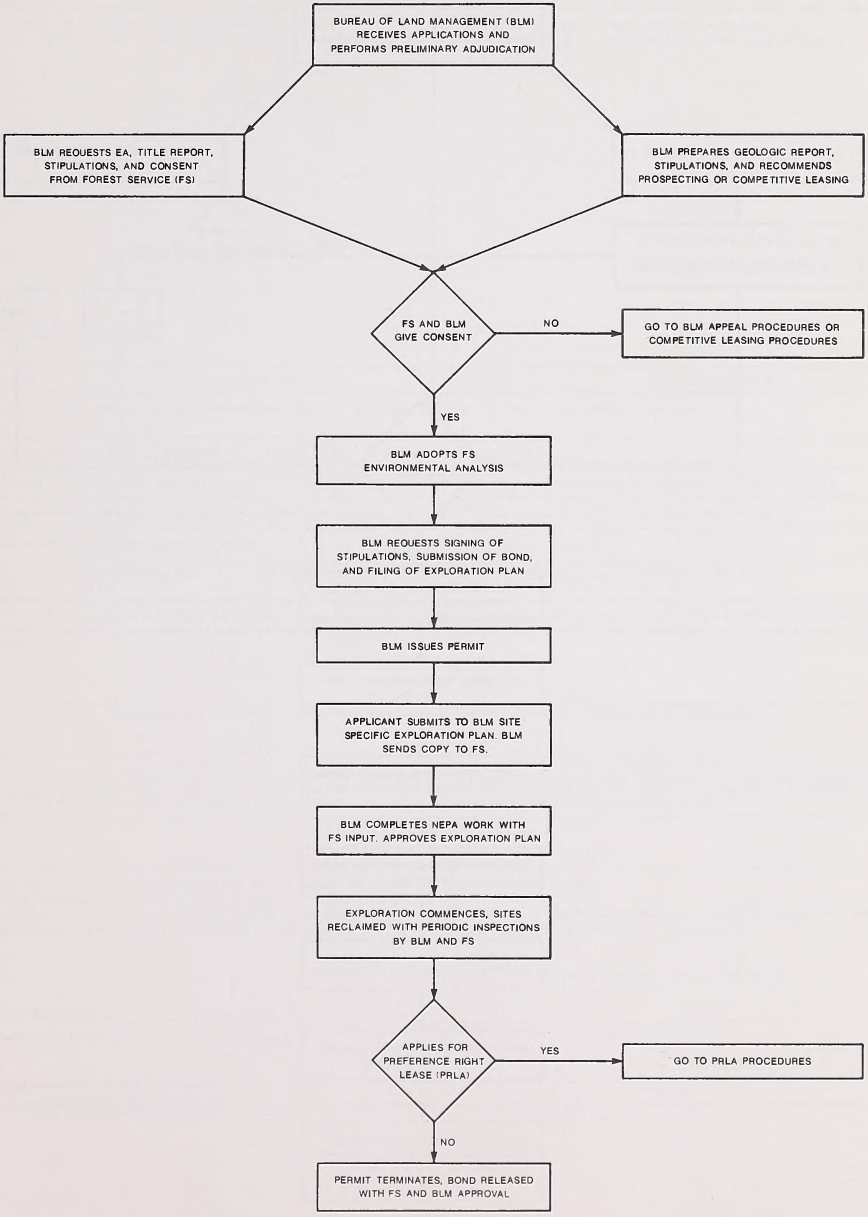
Before beginning any operations, the lessee must submit a plan of operations (43 CFR Subpart 3592) to the Bureau describing in detail all proposed operations and reclamation requirements. The plan of operations has to be consistent with the requirements of the lease for the protection of non-mineral resources and for the reclamation of lands affected by the operations. The plan is reviewed by the Bureau and Forest Service and an environmental analysis is jointly prepared to assess impacts of mining and to develop mitigation measures that will be made conditions of approval to the mining plan. Once the plan has been approved and operations have begun, the Bureau initiates a periodic inspection program to monitor all activities conducted on the lease. When the lease(s) terminate or mining operations cease all reclamation is completed in accordance with the plan of operations. The bond is released only when both agencies are satisfied that reclamation is complete and all conditions of the lease have been met.

Competitive Lease

Where sufficient information indicates the existence or workability of a valuable hardrock mineral deposit for lands not under a preference right lease application, those lands may be leased only through competitive sale (43 CFR Subpart 3564). A competitive lease sale may be initiated either through an expression of interest or on Bureau motion. Prior to a competitive lease offering, the Bureau requests a title report, environmental analysis, lease stipulations and lease consent from the Forest Service. The Bureau then publishes a notice of sale. This notice provides the time and place of the sale, description of the tract(s) being offered, information on the lease sale procedures and conditions under which the lands may be leased.

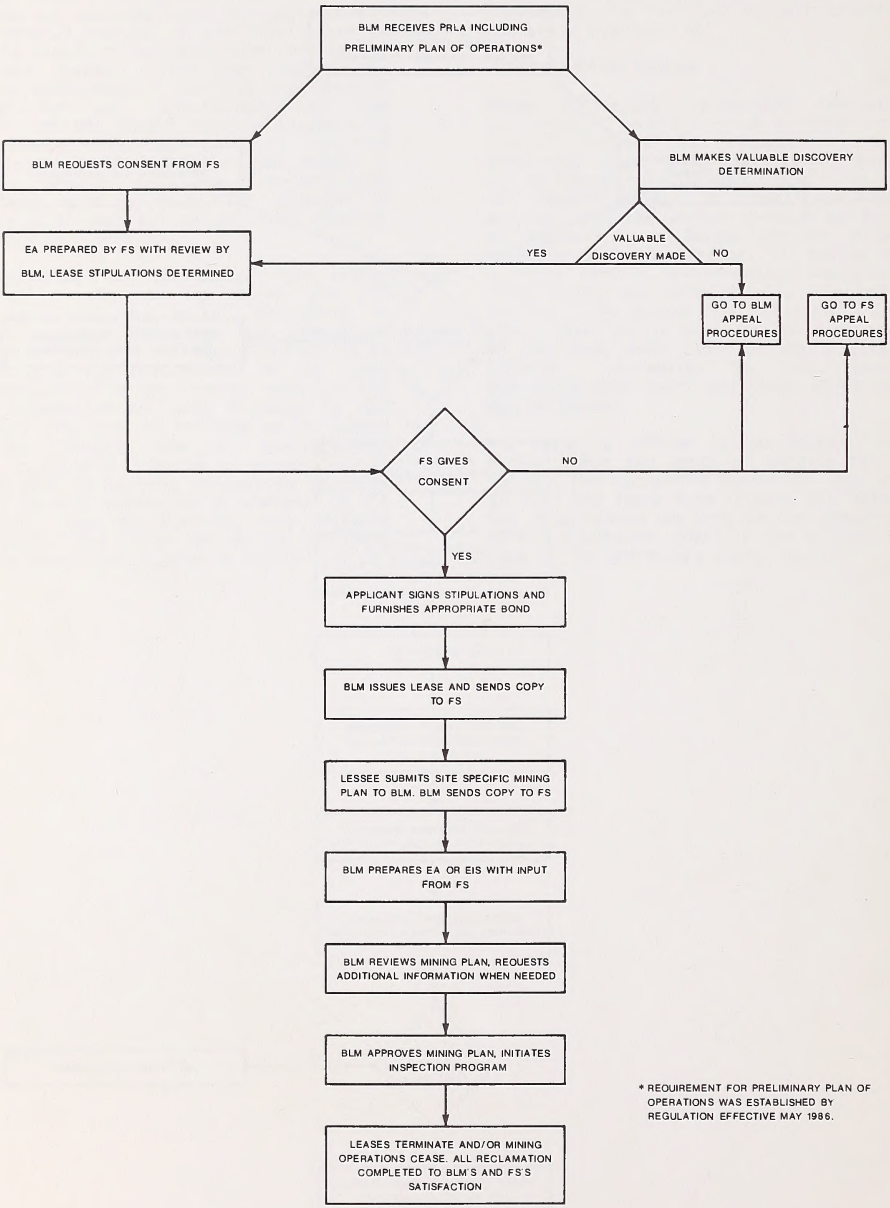
The lease is offered to the highest qualified bidder whose bid meets or exceeds fair market value. The successful bidder is then required to sign the lease form (Figure 2D), acknowledge any stipulations and provide the required lease bond. Subsequent steps in the process are the same as for preference right leases.

FIGURE 2A
PROSPECTING PERMIT PROCESS



Source: Bureau of Land Management, 1987.

FIGURE 2B
PREFERENCE RIGHT LEASE PROCESS



* REQUIREMENT FOR PRELIMINARY PLAN OF OPERATIONS WAS ESTABLISHED BY REGULATION EFFECTIVE MAY 1986.

Source: Bureau of Land Management, 1987.

Form 3510-1
(May 1984)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FORM APPROVED
OMB NO. 1004-0030
Expires: April 30, 1987

PROSPECTING APPLICATION AND PERMIT

1. What mineral are you applying for?

2. Give legal description of land requested *(See General Instruction for assistance on land description if needed)*

3. Legal description of land included in permit
APPLICANT DOES NOT FILL IN THIS SPACE

Total acres	Rental submitted $	Total acres	Rental retained $

4. Are the lands administered by a government agency? ☐ Yes ☐ No *(If "yes," give name of agency)*

5. Are you the sole party in interest? ☐ Yes ☐ No *(See Specific Instruction No. 5)*

6a. Are you a citizen of the United States? ☐ Yes ☐ No

b. Are you over the age of majority? ☐ Yes ☐ No

7a. Is application made for a corporation or other legal entity? ☐ Yes ☐ No *(See Specific Instructions No. 7a and 7b)*

b. Has a statement of qualification been filed? ☐ Yes ☐ No *(If "yes," give file number)*

8. Have you enclosed a filing fee of $ ☐ Yes

9. Have you enclosed the first year's advance rental computed at the rate of ¢ per acre? ☐ Yes *(See Specific Instruction No. 9)*

I CERTIFY That my interests, direct or indirect, in leases, permits, and applications therefor, do not exceed the maximum permitted by law or regulation; and that the statements made herein are true, complete, and correct to the best of my knowledge and belief and are made in good faith.

(Signature of Applicant)

(Signature of Applicant)

(Date)

(Attorney-in-fact)

Title 18 U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

DO NOT WRITE BELOW THIS LINE

_____ PROSPECTING PERMIT

A permit for the lands in Item 3, above is hereby issued under the ☐ Mineral Leasing Act, 30 U.S.C. 181 *et seq.* ☐ Acquired Lands Leasing Act, 30 U.S.C. 351 *et seq.* ☐ 43 CFR 3511 *et seq.* and is subject to all regulations in force and to the terms and conditions set forth on the reverse side hereof.

This permit, to the extent applicable, is subject to standard or special stipulations. Stipulations if any, are attached.

THE UNITED STATES OF AMERICA

Effective date of permit _____ By _____
(Signing Officer)

This permit is issued for a period of _____ years

(Title)

Sec. 1. *Prospecting.* Permittee shall diligently prospect the lands by core drilling or other acceptable methods. Permittee shall notify the authorized officer in which the permit lands are situated of his plans for prospecting prior to commencement of prospect work.

Sec. 2. *Operating regulations.* (a) Permittee shall comply with all regulations of the Secretary of the Interior; and, as to the lands described herein under his jurisdiction, to the regulations and orders of the Secretary of Agriculture.

(b) Permittee shall comply with the provisions of the operating regulations of the Bureau of Land Management (43 CFR 3570) and all orders issued pursuant thereto. Copies of the operating regulations may be obtained from the authorized officer.

(c) Permittee shall not prospect lands under administrative jurisdiction of the Forest Service without prior notice to and consent of that Service to a plan for prospecting.

(d) Permittee shall allow inspection of the premises and operations by duly authorized representatives of the Departments of the Interior, Agriculture, or other agency administering the lands and shall provide for the free ingress or egress of Government officers and for users of the lands under authority of the United States.

Sec. 3. *Multiple use.* (a) Valid existing rights acquired prior hereto on the lands described herein will not be adversely affected hereby.

(b) The granting of this permit will not preclude the issuance of other permits, leases, or other development of the same lands.

(c) The permitted lands shall be subject, at all times, to any other lawful uses by the United States, its lessees, permittees, licensees, and assigns, but such use shall not materially interfere with the permittee's operations hereunder.

(d) The Government reserves the right to sell or otherwise dispose of the surface of the permitted lands under existing law or laws hereafter enacted, insofar as such disposal will not materially interfere with the rights of the permittee.

(e) The permittee shall afford all facilities for inspection of the prospecting work on behalf of the Secretary of the Interior or head of agency administering the lands and to make a report, on demand, of all matters pertaining to the character, progress, and results of such work.

(f) The permittee shall observe such conditions as to the use and occupancy of the surface of the lands as provided by law, in case any of said lands shall have been or may be entered or patented with a reservation of mineral deposits to the United States.

Sec. 4. *Removal of deposits.* Permittee shall remove from the lands only such deposits as may be necessary to experimental work or to establish the existence of valuable deposits within the permit area and shall keep a record of all mineral mined.

Sec. 5. *Rental.* Permittee *must* pay an annual rental of cents per acre, or fraction thereof, *but not less than $20 per year.* The annual rental payment shall be made *on or before* the anniversary date of the permit.

Sec. 6. *Extension of permit.* (a) This permit may be subject to extension under applicable regulation upon approval of the authorized officer of the Bureau of Land Management and upon the showing of entitlement thereto.

(b) Application for extension of this permit, where authorized by law or regulation, must be filed, in *duplicate,* in the proper BLM office within the period beginning 90 days prior to the date of expiration of this permit. Unless such an application is filed within the time specified, this permit will expire without notice to the permittee.

Sec. 7. *Reward for discovery.* Permittee may apply for a preference-right lease if he shall have discovered valuable deposits of minerals covered by this permit within the permit area and within the period of this permit as issued. The showing required to be made in the preference-right lease application is set forth in the appropriate regulation. In addition, the applicant for a sodium, potassium, or sulphur preference-right lease must show that the lands applied for are chiefly valuable. See appropriate regulations. Also see appropriate regulation for limitation on acreage holdings.

Sec. 8. *Equal opportunity clause.* This permit is subject to the provisions of Executive Order No. 11246 of Sept. 24, 1965, as amended, which sets forth the nondiscrimination clauses. A copy of this order may be obtained from the signing officer.

Sec. 9. *Assignments.* All assignments or transfers of this permit or of any interest therein, whether by direct assignment, operating agreement, sublease, working interest, royalty interest, or otherwise, *must* be filed with the Bureau of Land Management for approval in accordance with the provisions of the appropriate regulation and will take effect as of the first day of the month following approval thereof, or, if transferee so requests, as of the first day of the month during which such approval is given.

Sec. 10. *Relinquishment of permit.* Permittee may relinquish this permit, in whole or part, by filing in the proper BLM office a written relinquishment, in *triplicate,* which shall be effective as of the date it is filed, subject to the continued obligation of permittee and his surety to make payment of all accrued rentals and royalties; and, to provide for the preservation of any mines or productive works, or permanent improvements on the permit land as required by the applicable regulations and terms of this permit.

Sec. 11. *Termination or cancellation.* (a) This permit shall terminate automatically upon failure of the permittee to pay the rental *on or before* the anniversary date thereof, except that if the time for payment falls upon any day in which the appropriate land office to receive payment is not open, payment received on the next official working day shall be deemed to be timely.

(b) This permit may be cancelled in accordance with the regulations upon failure by permittee to exercise due diligence in the prosecution of the prospecting work or for violation of any terms and conditions hereof, or any of the pertinent regulations.

Sec. 12. *Protection of surface, natural resources, and improvements.* The permittee agrees to take such reasonable steps as may be needed to prevent operations on the permitted lands from unnecessarily: (1) causing or contributing to soil erosion or damaging crops, including forage, and timber growth thereon or on Federal or non-Federal lands in the vicinity; (2) polluting air and water; (3) damaging improvements owned by the United States or other parties; or (4) destroying, damaging or removing fossils, historic or prehistoric ruins, or artifacts; and upon any partial or total relinquishment or the cancellation or expiration of this permit, or at any other time prior thereto when required and to the extent deemed necessary by the lessor to fill any pits, ditches and other excavations, remove or cover all debris, and so far as reasonably possible, restore the surface of the permitted land and access roads to their former condition, including the removal of structures as and if required. The lessor may prescribe the steps to be taken and restoration to be made with respect to the permitted lands and improvements thereon whether or not owned by the United States.

Sec. 13. *Antiquities and objects of historic value.* When American antiquities or other objects of historic or scientific interest including but not limited to historic or prehistoric ruins, fossils or artifacts are discovered in the performances of this permit, the item(s) or condition(s) will be left intact and immediately brought to the attention of the contracting officer or his authorized representative.

Sec. 14. *Sodium deposits in oil shale areas.* If this application is for sodium minerals in the oil shale area described in P.L.O. 4522, September 24, 1968, a prospecting permit will be issued only in those areas where it is believed likely that, if sodium deposits are found, they will occur in discrete beds where development of the sodium deposits would not adversely affect the oil shale values of the lands. Any sodium prospecting permits or preference-right leases that may issue on these oil shale lands will be restricted to those beds valuable for sodium which the Secretary of the Interior or his delegate determines to be workable without removal of significant amounts of organic matter and without significant damage to oil shale beds.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

_____ LEASE

Serial Number

PART I. LEASE RIGHTS GRANTED.

This ☐ Lease ☐ Lease Renewal entered into by and between the UNITED STATES OF AMERICA, through the Bureau of Land Management, hereinafter called lessor, and *(Name and Address)*

hereinafter called lessee, is effective *(date)* , for a period of years,

Sodium, Sulphur, Hardrock –

☐ with preferential right in the lessee to renew for successive periods of years under such terms and conditions as may be prescribed by the Secretary of the Interior, unless otherwise provided by law at the expiration of any period.

Potassium, Phosphate, Gilsonite –

☐ and for so long thereafter as lessee complies with the terms and conditions of this lease which are subject to readjustment at the end of each year period, unless otherwise provided by law.

Sec. 1. This lease is issued pursuant and subject to the terms and provisions of the:

☐ Mineral Leasing Act of 1920, as amended, and supplemented, 41 Stat. 437, 30 U.S.C. 181–287, hereinafter referred to as the Act;

☐ Mineral Leasing Act for Acquired Lands, Act of August 7, 1947, 61 Stat. 913, 30 U.S.C. 351–359;

☐ Reorganization Plan No. 3 of 1946, 60 Stat. 1099 and 43 U.S.C. 1201;

☐ *(Other)* ; and

to the regulations and general mining orders of the Secretary of the Interior in force on the date this lease issued.

Sec. 2. Lessor, in consideration of any bonuses, rents, and royalties to be paid, and the conditions and covenants to be observed as herein set forth, hereby grants and leases to lessee the exclusive right and privilege to explore for, drill for, mine, extract, remove, beneficiate, concentrate, or otherwise process and dispose of the deposits hereinafter referred to as "leased deposits," in, upon, or under the following described lands:

containing acres, more or less, together with the right to construct such works, buildings, plants, structures, equipment and appliances and the right to use such on-lease rights-of-way which may be necessary and convenient in the exercise of the rights and privileges granted, subject to the conditions herein provided.

Phosphate –

☐ In accordance with Section 11 of the Act (30 U.S.C. 213), lessee may use deposits of silica, limestone, or other rock in the processing or refining of the phosphates, phosphate rock, and associated or related minerals mined from the leased lands or other lands upon payments of royalty as set forth on the attachment to this lease. *(Phosphate leases only.)*

Form 3520–7 (December 1984)

PART II. TERMS AND CONDITIONS

Sec. 1. (a) RENTAL RATE – Lessee shall pay lessor rental annually and in advance for each acre or fraction thereof during the continuance of the lease at the rate indicated below:

Sulphur, Gilsonite –

☐ 50 cents for the first lease year and each succeeding lease year;

Hardrock –

☐ $1 for the first lease year and $1 for each succeeding lease year;

Phosphate –

☐ 25 cents for the first lease year, 50 cents for the second and third lease years, and $1 for each and every lease year thereafter;

Potassium, Sodium –

☐ 25 cents for the first calendar year or fraction thereof, 50 cents for the second, third, fourth, and fifth calendar years respectively, and $1 for the sixth and each succeeding calendar year; or

Sodium, Sulphur, Asphalt, and Hardrock Renewal Leases –

☐ $ for each lease year;

(b) RENTAL CREDITS – The rental for any year will be credited against the first royalties as they accrue under the lease during the year for which rental was paid.

Sec. 2. (a) PRODUCTION ROYALTIES – Lessee shall pay lessor a production royalty in accordance with the attached schedule. Such production royalty is due the last day of the month next following the month in which the minerals are sold or removed from the leased lands.

(b) MINIMUM ANNUAL PRODUCTION AND MINIMUM ROYALTY – (1) Lessee shall produce on an annual basis a minimum amount of , except when production is interrupted by strikes, the elements, or casualties not attributable to the lessee. Lessor may permit suspension of operations under the lease when marketing conditions are such that the lease cannot be operated except at a loss. (2) At the request of the lessee, made prior to initiation of the lease year, the authorized officer may allow in writing the payment of a $3.00 per acre or fraction thereof minimum royalty in lieu of production for any particular lease year. Minimum royalty payments shall be credited to production royalties for that year.

Sec. 3. REDUCTION AND SUSPENSION – In accordance with Section 39 of the Mineral Leasing Act, 30 U.S.C. 209, the lessor reserves the authority to waive, suspend or reduce rental or minimum royalty, or to reduce royalty, and reserves the authority to assent to or order the suspension of this lease.

Sec. 4. BONDS – Lessee shall maintain in the proper office a lease bond in the amount of $, or in lieu thereof, an acceptable statewide or nationwide bond. The authorized officer may require an increase in this amount when additional coverage is determined appropriate.

Sec. 5. DOCUMENTS, EVIDENCE AND INSPECTION – At such times and in such form as lessor may prescribe, lessee shall furnish detailed statements showing the amounts and quality of all products removed and sold from the lease, the proceeds therefrom, and the amount used for production purposes or unavoidably lost.

Lessee shall keep open at all reasonable times for the inspection of any duly authorized officer of lessor, the leased premises and all surface and underground improvements, work, machinery, ore stockpiles, equipment, and all books, accounts, maps, and records relative to operations, surveys, or investigations on or under the leased lands.

Lessee shall either submit or provide lessor access to and copying of documents reasonably necessary to verify lessee compliance with terms and conditions of the lease.

While this lease remains in effect, information obtained under this section shall be closed to inspection by the public in accordance with the Freedom of Information Act (5 U.S.C. 552).

Sec. 6. DAMAGES TO PROPERTY AND CONDUCT OF OPERATIONS – Lessee shall exercise reasonable diligence, skill, and care in the operation of the property, and carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health or property, and of waste or damage to any water or mineral deposits.

Lessee shall not conduct exploration or operations, other than casual use, prior to receipt of necessary permits or approval of plans of operations by lessor.

Lessee shall carry on all operations in accordance with approved methods and practices as provided in the operating regulations, and the approved mining plans in a manner that minimizes adverse impacts to the land, air, and water, to cultural, biological, visual, minerals, and other resources, and to other land uses or users. Lessee shall take measures deemed necessary by lessor to accomplish the intent of this lease term. Such measures may include, but are not limited to, modification to proposed siting or design of facilities, timing of operations, and specification of interim and final reclamation procedures.

Lessor reserves to itself the right to lease, sell, or otherwise dispose of the surface or other mineral deposits in the lands and the right to continue existing uses and to authorize future uses upon or in the leased lands, including issuing leases for mineral deposits not covered hereunder or the approval of easements or rights-of-way. Lessor shall condition such uses to prevent unnecessary or unreasonable interference with rights of lessee as may be consistent with concepts of multiple use and multiple mineral development.

Sec. 7. PROTECTION OF DIVERSE INTERESTS, AND EQUAL OPPORTUNITY – Lessee shall: pay when due all taxes legally assessed and levied under the laws of the State or the United States; accord all employees complete freedom of purchase; pay all wages at least twice each month in lawful money of the United States; maintain a safe working environment in accordance with standard industry practices; restrict the workday to not more than 8 hours in any one day for underground workers, except in emergencies; and take measures necessary to protect the health and safety of the public. No person under the age of 16 years shall be employed in any mine below the surface. To the extent that laws of the State in which the lands are

situated are more restrictive than the provisions in this paragraph, then the State laws apply.

Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and the rules, regulations, and relevant orders of the Secretary of Labor. Neither lessee nor lessee's subcontractors shall maintain segregated facilities.

Sec. 8. (a) TRANSFERS – This lease may be transferred in whole or in part to any person, association or corporation qualified to hold such lease interest.

(b) RELINQUISHMENT – The lessee may relinquish in writing at any time all rights under this lease or any portion thereof as provided in the regulations. Upon lessor's acceptance of the relinquishment, lessee shall be relieved of all future obligations under the lease or the relinquished portion thereof, whichever is applicable.

Sec. 9. DELIVERY OF PREMISES, REMOVAL OF MACHINERY, EQUIPMENT, ETC. – At such time as all or portions of this lease are returned to lessor, lessee shall deliver up to lessor the land leased, underground timbering, and such other supports and structures necessary for the preservation of the mine workings on the leased premises or deposits and place all wells in condition for suspension or abandonment. Within 180 days thereof, lessee shall remove from the premises all other structures, machinery, equipment, tools, and materials that it elects to or as required by the authorized officer. Any such structures, machinery, equipment, tools, and materials remaining on the leased lands beyond 180 days, or approved extension thereof, shall become the property of the lessor, but lessee shall either remove any or all such property or shall continue to be liable for the cost of removal and disposal in the amount actually incurred by the lessor. If the surface is owned by third parties, lessor shall waive the requirement for removal, provided the third parties do not object to such waiver. Lessee shall, prior to the termination of bond liability or at any other time when required and in accordance with all applicable laws and regulations, reclaim all lands the surface of which has been disturbed, dispose of all debris or solid waste, repair the offsite and onsite damage caused by lessee's activity or activities on the leased lands, and reclaim access roads or trails.

Sec. 10. PROCEEDINGS IN CASE OF DEFAULT – If lessee fails to comply with applicable laws, now existing regulations, or the terms, conditions and stipulations of this lease, and the noncompliance continues for 30 days after written notice thereof, this lease shall be subject to cancellation by the lessor only by judicial proceedings. This provision shall not be construed to prevent the exercise by lessor of any other legal and equitable remedy, including waiver of the default. Any such remedy or waiver shall not prevent later cancellation for the same default occuring at any other time.

Sec. 11. HEIRS AND SUCCESSORS-IN-INTEREST – Each obligation of this lease shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 12. INDEMNIFICATION – Lessee shall indemnify and hold harmless the United States from any and all claims arising out of the lessee's activities and operations under this lease.

Sec. 13. SPECIAL STATUTES – This lease is subject to the Federal Water Pollution Control Act (33 U.S.C. 1151–1175), the Clean Air Act (42 U.S.C. 1857 et. seq.), and to all other applicable laws pertaining to exploration activities, mining operations and reclamation.

Sec. 14. SPECIAL STIPULATIONS –

(Section 14 continued on reverse)

THE UNITED STATES OF AMERICA

By

Company or Lessee Name

(Signature of Lessee) *(Signing Officer)*

(Title) *(Title)*

(Date) *(Date)*

Title 18 U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

NOTICE

The Privacy Act of 1974 and the regulations in 43 CFR 2.48(d) provides that you be furinshed the following information in connection with information required under the terms of this lease.

AUTHORITY: 30 U.S.C. 181 et seq.; 43 CFR 3500.

PRINCIPAL PURPOSE: The information will be used to verify your compliance with the lease terms and in calculating royalty payments.

ROUTINE USES: (1) Evaluation of the effects of the operations on the environment. (2) Statistical reports to Congress. (3)(4) and (5) Information from the record and/or the record may be released or transferred to appropriate Federal, State or local agencies in allocating mineral revenue, for investigations of energy programs; and when relevant to civil, criminal or regulatory investigations or prosecutions, as well as routine regulatory responsibility.

EFFECT OF NOT PROVIDING INFORMATION: Disclosure of this information is mandatory only if the lessee elects to mine, extract, remove and/or dispose of the leased deposits.

The Paperwork Reduction Act of 1980 (44 U.S.C. 3501 et seq.) requires us to inform you that:

This information is being collected for use in calculating royalty payments and in verification of compliance with lease terms.

Response to this request is mandatory only if the lessee elects to mine, extract, remove and/or dispose of the leased deposits.

☆ U.S. Government Printing Office: 1985—473-299/29981

APPENDIX 3

SUMMARY OF SCOPING

SCOPING COMMENT INFORMATION

Table 3A presents the number of comments received by comment category from each of three geographic locations consisting of the six-county analysis area, other Missouri locations and out of State. Table 3B shows the highest six issues of scoping participants for each of the geographic or interest areas.

DEMOGRAPHIC INFORMATION

Tables 3C and 3D provide demographic information supplemental to that contained in Chapter One: Purpose and Need. Both tables outline categories of respondents who participated in scoping, the number of participants by respondent category, and the geographic interest area. Table 3C summarizes this information for those comments received in response to the Environmental Analysis and Table 3D summarizes the same data for the EIS scoping process.

RESPONSE TO COMMENTS

A summary of the comments received and the responses prepared to answer the comments is contained om "List of Comments and Study Team Responses". The comment statements (bold type) have been grouped by issue subject. Following the statement is a list of numbers which refer to respondents identified in "List of Scoping Participants". Numbers up to 119 are respondents providing comments during EIS scoping. Numbers 501 through 578 are those respondents providing comments during the EA review. Where more than one comment statement is given before a response statement appears, the response statement refers to each of the comments listed above it. For purposes of replying to comments from the public and cooperating agencies, representative comment statements have been prepared.

TABLE 3A
NUMBER OF COMMENTS BY CATEGORY

Comment	Six Co. Analysis	Out Area	MO	MO
Visual Resources	9	1	8	-
Roads	1	-	1	-
Trails	4	-	4	-
Soil	3	1	2	-
Water	69	34	34	1
Geology	17	6	11	-
Mining Activities	81	31	48	2
Land Base	2	-	-	2
Wildlife and Fish	15	2	10	3
Recreation	9	3	6	-
Eleven Point	25	10	15	-
Wilderness	7	-	7	-
Economic Environment	64	44	19	1
Social Environment	39	38	1	-
Special Areas	2	-	1	1
Air Quality	2	1	1	-
Waste Disposal	22	14	8	-
EIS Process	53	15	25	13
Ozark Scenic Rivers	19	5	11	3
Protection of Environment	44	15	28	1
Public Health Safety	11	6	5	-
Caves	2	-	-	2
Enforcement/ Monitoring	20	12	8	-
Cultural Resources	3	-	2	1
Rare Plants	2	-	2	1
TOTALS	525	238	257	30

Source: USDA-Forest Service, 1987.

TABLE 3B
HIGHEST SIX ISSUES OF SCOPING PARTICIPANTS

SIX COUNTY ANALYSIS AREA

Economic Environment
Social Environment
Water
Mining Activities
EIS Process
Protection of Environment

OTHER MISSOURI LOCATIONS

Mining Activities
Water
Protection of Environment
EIS Process
Economic Environment
Eleven Point National Scenic River

OUTSIDE OF MISSOURI

EIS Process
Ozark Scenic Riverways
Land Base
Wildlife and Fish
Mining Activities
Caves

TABLE 3C
PUBLIC RESPONSE TO ENVIRONMENTAL ANALYSIS

Respondent Description	Origin of Response 1/	Number of Responses (Respondents 2/)
Individual	A	20 (23)
	B	23 (51)
	C	6 (6)
Total (Individual)		49 (80)
Commodity Interest	B	6 (6)
Service Interest	A	1 (1)
Civic and Community Groups	A	2 (2)
Advocates of Primitive and Non-game Recreation Use	A	1 (1)
	B	1 (2)
	C	2 (2)
Total (Primitive)		4 (5)
Advocates of Wilderness Recreation Use	B	2 (2)
	C	1 (1)
Total (Wilderness)		3 (3)
Professional Societies	B	2 (2)
EIS Cooperator	A	1 (1)
	B	6 (6)
	C	2 (2)
Total (Cooperator)		9 (9)
Other	C	2 (2)

1/ A, Six-county analysis area; B, Missouri; C, Outside Missouri.

2/ Number of respondents may be more than responses due to multiple signatures.

Source: USDA-Forest Service, 1987

TABLE 3D
PUBLIC RESPONSE TO ENVIRONMENTAL IMPACT STATEMENT SCOPING PROCESS

Respondent Description	Origin of Response 1/	Number of Responses (Respondents 2/)
	A	37 (504)
Individual	B	39 (42)
	C	2 (2)
Total (Individual)		79 (548)
Commodity Interest	A	2 (2)
	B	7 (5)
Total (Commodity)		9 (7)
Service Interest	A	1 (1)
Civic Groups	A	2 (2)
Community Groups	B	1 (2)
Total (Service)		3 (4)
Academic Interest	B	1 (1)
Organizations Advocating Primitive Non-game Recreation Use	A	1 (1)
	B	2 (2)
	C	1 (1)
Total (Primitive)		4 (4)
Organizations Advocating Sport Hunting and Fishing	B	1 (1)
Organizations Advocating Wilderness Recreation	B	4 (3)
	C	1 (1)
Total (Wilderness)		5 (4)
Professional Societies	B	2 (2)
Elected Officials Local	A	1 (1)
Elected Officials Federal	B	1 (1)
Public Agency State	C	1 (1)
Forest Service Employee	B	1 (1)
EIS Cooperators	A	2 (2)
	B	1 (3)
	C	1 (1)
Total (Cooperators)		4 (6)

1/ A, Six-county analysis area; B, Missouri; C, Outside Missouri.

2/ Number of respondents may be more than responses due to multiple signatures.

Source: USDA-Forest Service, 1987

LIST OF COMMENTS AND STUDY TEAM RESPONSES

ISSUE 1: WATER RESOURCES

Issues

1. Expressed concern about pollution of the Eleven Point National Scenic River, the Ozark Scenic Riverway, and the lower Current River due to by silt, heavy metals, flow alteration, or other mining effluents. (17, 20, 22, 29, 39, 42, 44, 61, 64, 76, 113, 118, 509, 510, 511, 513, 516, 522, 523, 524, 528, 534, 536, 539, 540, 541, 543, 546, 551, 552, 555, 556, 558, 559, 560, 562, 569, 570, 571, 572, 573, 574, 578)

   Response:
   The possibilities of flow alteration and pollution of the Current and Eleven Point Rivers will be exhaustively discussed in the EIS. The State Water Quality Plan forbids any degradation of existing water quality in these two streams. If water quality can not be protected there will not be any mining.

2. General concern about pollution of ground and surface water and what effect this would have on springs, wellwater, sport fishing, aquatic life, fish and wildlife habitat, plant and animal life, ecosystems, and scenic and recreational opportunities. Along with these effects, associated problems with drilling and shaft sinking, ore transport and possible spills, tailings pond collapse, sewage disposal, and lead and heavy metals were also expressed. (6, 10, 12, 33, 34, 35, 38, 39, 44, 53, 55, 58, 59, 67, 73, 76, 78, 84, 85, 91, 96, 110, 111, 113, 114, 116, 118, 510, 512, 513, 514, 522, 525, 526, 530, 532, 533, 536, 538, 542, 544, 547, 548, 549, 550, 561, 563, 566, 569, 573, 577)

   Response:
   Ground and surface water quality and pollution will be major discussion points in the EIS.

3. Clean water is a valuable commodity and it must be protected. (50, 58, 59, 67, 68, 109, 557, 559, 568)

   Response:
   This is absolutely true. Requirements of the State Water Quality Plan will be met.

4. There are other impacts expected on ground and surface waters. Noted among these are changes in pH, temperature, odor, flow, turbidity, and manganese deposition. Effects need more study. (509, 532, 559, 566, 572)

   Response:
   The Draft EIS will contain discussion on every significant aspect of ground and surface water quantity and quality that we can think of. It is true that effects may need more study prior to mining, but it is questionable whether or not more study is needed to make the lease issuance/denial decision.

5. The area geology was not depicted accurately in the EA. Karst topography areas and sinkholes are not necessarily related to mining activity and collapse of tailings ponds. This relationship is undocumented. (503)

   Response:
   The area's hydrogeology has been intensively studied since the mid-1960s, and it is accurately portrayed in the Environmental Assessment.

6. Constraints on drilling in floodplains and other similar areas should be eliminated. (505)

   Response:
   We will consider it, but can make no promises of elimination.

7. New dye tracing should be done to get sufficient and current groundwater data. (513)

   Response:
   New dye tracing would be needed only if a mine is actually proposed, which it has not been. New tracing information would not contribute anything vital to the lease issuance/denial decision process.

8. Alkaline nature of gangue material prohibits tailings from going into solution and entering the groundwater. (506, 507, 508)

   Response:
   This is largely true, but insoluble gangue also may have adverse environmental effects. Both possibilities will be explored in the Draft EIS.

9. Consider tailings disposal when a mine development plan is submitted or when more information is available. (501, 502, 503, 505, 507)

   Response:
   Final selection of a safe tailings disposal method would be done during the mine development planning process. Much information would be required that is presently unavailable. It is possible that the only environmentally safe method might be so expensive that mining would be uneconomical.

10. Five year stream flow gaging is unnecessary now (502, 505, 506, 508)

    Response:
    This is correct. There is no need for streamflow gaging until a mineable ore body is proven and specific tailings pond

sites are proposed. The purpose of streamflow gaging would be to determinewhether or not specific sites are watertight enough to prevent groundwater contamination.

11. There is much concern over pollution of wells and drinking water supplies of the local area. (33, 38, 59, 509, 522, 548, 555, 556, 557, 565, 569, 578)

Response:
We agree and the subject will be discussed in the Draft EIS.

12. Fish in waters with higher than normal lead and other heavy metal concentrations pick these elements up and concentrate them in bones, skin, and scales. Fish such as suckers that are cooked whole pass these metals to the meat during cooking. Levels higher than FDA levels have been found in the Big River and a health advisory against eating these fish has been issued. Local people are concerned about whether or not fish from rivers in or near the study area would be safe to eat if mining occurred. (509, 532, 534, 548)

Response:
The comment is correct. The Draft EIS will discuss this in more detail than what was presented in the Environmental Assessment.

13. Lead is known or suspected to be harmful to human health, but more information regarding the effects on humans, plants, and animals is needed. Health problems with lead have the potential to be very serious and the risk of contaminating wells and groundwater supplies which are used for drinking water is too great. (33, 38, 59, 523, 540, 541, 559, 565, 571)

Response:
The Draft EIS will include a discussion on possibilities and potential effects of lead contamination.

14. Pay particular attention to the degradation of water quality within the region from the release of mill tailings, reagents, and heavy metals, which the Environmental Assessment termed inevitable, in light of the permeable geohydrology of the proposed lease area. Also consider impacts upon wildlife and fish from the release of toxic metals into the water systems and the adverse effects on aesthetic and recreational values that would result. (17, 20, 22, 29, 39, 42, 44, 61, 64, 76)

Response:
We will pay attention to all of these concerns and more.

15. A polluted underground water supply would not only jeopardize 50 years of effort expended by the Forest Service and the Missouri Department of Conservation in restoring and maintaining this garden paradise in the hill country, it could cause irrepairable damage with collossal consequences to present and future generations living within and adjacent to National Forest lands. (39,44)

Another important resource in the study area and adjacent to it is the great number of caves, many of them being wet caves that could be seriously impacted by contamination of the groundwater. Effluent discharged from mining activities could cause serious and irreversible damage to populations of vertebrate and invertebrate cave fauna through groundwater pollution. (7, 110)

Response:
We will pay close attention to the possibility of groundwater contamination and the effects that it would have.

16. It is against Missouri Natural Resource regulations to emit any kind of effluent, including mining effluent into Big Spring whether intentional or unintentional. (31)

Response:
This is true. Uncontaminated minewater discharge is allowed, but other kinds of effluent are not.

17. Assessing the hydrologic impact alone of a mining operation is a very complex problem which should be undertaken by a competent, independent agency. (42)

Response:
No one has yet proposed a mining operation. The mineral leasing Draft EIS is being done by several State and Federal cooperating agencies.

18. You have under review a very large study area. It includes recharge areas for a number of springs where it has the potential for affecting a number of different wells, with a great deal of variability. If you are to make a realistic and useful assessment for such a large area, then you are going to need quite a bit of data. If you do not have quite a bit of data, then what is the significance or value of the documents that you prepare. (34)

Response:
Having the right data to answer the relevant questions is more important than having a lot of data about everything.

19. We are concerned about potential impacts on Greer Spring, a National Landmark, located in Sections 35 and 36, T24N, R35W. Greer Spring is significant from a hydrologic, geologic, and biologic standpoint. (110)

Response:
We are concerned too, and will evaluate

the possible impacts as best we can in the Draft EIS.

20. The few jobs that the proposed drilling and mining operation would bring on a temporary basis would be less than the ones lost on a permanent basis if these rivers lose their attraction to tourists. (63)

Response:
We will evaluate the validity of these concerns.

21. Please remember the significance of water, especially groundwater, to the people of this area and to the existing economy. I have heard a lot of discussion about economics tonight. I am in favor of jobs, I like them myself. I am in favor of rivers. I like them too. I like floating. I like fishing. I like all these things. Really what I think all of us want is the economy richer, not poorer. We do not become richer by destroying something, while gaining something else. (34, 59)

Response:
Most of us like these things too. Consideration will be given to these thoughts in the Draft EIS.

22. Underground tailings storage may be an option that satisfies both mining companies and environmentalists. The springs, caves, and underground rivers all occur far above the mineralized rock. Piling waste on top of that system very likely will cause heavy metal pollution of the ecosystem, but storing tailings back in the mine poses no more threat than the natural beds of lead-rich rock that were there. (16)

Response:
There is much interest in underground tailing storage and the Draft EIS will cover it.

23. The area that we are concerned with is a Karst area and it is a source of recharge for a large number of streams, caves, and springs. We feel that it is just an extremely inappropriate place to have mining and that mining would pollute the ground water. (13, 31, 52, 76, 80, 84)

Response:
Your opposition to mining is recognized.

24. Ground water in the lease area is among the most vulnerable to pollution in the State. With rapid movement of potential pollutants from the surface through groundwater, which often surfaces at valuable springs. The development may be more difficult to pursue in an environmentally-safe manner than the Viburnum Area because of these geological features. (6, 85, 87)

Surface subsidence or collapse is a potentially adverse possibility and couldbe caused by mine dewatering and/or tailing pond impoundment. (6, 64)

Many of the streams in the area are "losing streams". They are surface streams that lose water into the groundwater system. This is a very open groundwater system that we have here and the depth to which the water circulates may be extremely deep, so we have the potential for contamination to substantial depths when it exists. (12, 15, 64, 97)

Those of us who live in southern Missouri counties are living with abundant clean water, the kind that is truly a national treasure. But this water is clean only by virtue of the low population density. Since we are living on virtually continuous karst topography, we are reminded in our daily living patterns of the extreme susceptibility of the area to groundwater pollution. (35, 36, 58)

Response:
These are all absolutely true statements that will be addressed in the Draft EIS.

25. This Department (of Natural Resources) recommends that buffer strips be provided to protect waterways in the Mark Twain National Forest. We believe that all of the classified waters in the lease area and in the Greer Spring area should be protected by wide buffer areas that will prevent any road building, drilling or other mining-related activities from adversely affecting these waters. (87)

Response:
Buffer strips are one of many ways to protect waterways. We will consider them.

26. This analysis is saturated with hazards, pitfalls, dangers, and potential catastrophic consequences probable from mining the fragile porous rock formations predominate in the proposed lease area. (6, 44, 64)

Response:
We will be studying ways to make the "possible" improbable.

27. In my opinion there is no such thing as an acceptable level of heavy metal pollution. I urge the EIS team to recommend that any mining lease granted include sufficient regulations, enforcement, and penalties to ensure no water pollution. (85)

Response:
Missouri Department of Natural Resources water quality regulations forbid degradation of existing water quality.

28. Heavy metal pollution of water from waste and tailings ponds in the proposed lease area would, in the words of the environmental analysis, be "inevitable". Once

water is so polluted, it stays that way. There is no known technology to clean it up. (6, 17, 20, 22, 29, 31, 39, 42, 44, 64, 76, 97)

Response:
The EA dealt with a very small area and assumed that a Viburnum Trend-type of tailings pond would be located there. It does not logically follow that other types of tailings disposal in the same or other locations would have the same inevitability of causing heavy metal pollution. Maybe they would and maybe they would not. Any type of mining and milling operation would have to comply with Missouri Department of Natural Resources regulations forbidding degradation of existing water quality. Your assertion that polluted water stays that way is incorrect, thank goodness for all of us.

29. The problem with lead sulfide is, that once it gets into the groundwater system, it is almost impossible to get out, once the mine is shut down and moved to greener pastures, which they always do. (29, 34, 63, 84)

Response:
We will study the validity of this allegation.

30. I drank that water over there for four years, and I have not heard about one well going bad. Now isn't that strange that just south of there, in Ellington is where all the water comes down through and have they got a problem? Do you know what they think of those tailing and sludge ponds? That's good fishing. They are clear. That's some of your better fishing in that area. Go up and see for yourselves. There's no run off. There isn't anything running up there. (37-48)

Response:
We'll consider this information.

31. The Department (of Natural Resources) recommends that the construction of road crossings in classified waters be minimized. (87)

Response:
This will be covered in the Draft EIS.

New Information

32. In 1978 the sewage lagoon in West Plains collapsed leaking sewage into the underground aquifers of the area. Movement was over 3 miles per day. (28)

There is also a sewage lagoon at Summersville that's dry and we've had a lot of rain. Twenty percent of the wells tested in the area are not fit to drink without a chlorinater. (38)

Response:
The leaky lagoons and contaminated springs and wells you mention are all too common examples of what can go wrong when hydrogeologic warnings go unheeded. Exhaustive hydrogeologic investigations and environmental safeguards would be required for mining to be permitted.

33. A report was prepared for EPA be the U.S. Geological Survey called Ground Water in the Springfield-Salem Plateaus of Southern Missouri and Northern Arkansas by Edward J. Harvey. The report makes a good case for considering most of the Ozark Plateau Region to be a "sole-source aquifer". (61)

Response:
We are familiar with the "sole-source aquifer" proposal for the Springfield and Salem Plateaus.

34. Section (5)(A) of the standards pertaining to ground water protection is very restrictive in that metal limits for aquifers are meant to protect both drinking water and aquatic life in surface waters. Section 7 of the effluent regulations, which pertain to recharge to subsurface waters, also contains these stringent limitations. (87)

Section (6) Of 10 CSR 20-7.015 (effluent regulations) pertains to Wild and Scenic Rivers and drainages thereto" and limits mining related activities to mine dewatering, and such discharges would be allowed only after very stringent assurances are given that the discharge will conform with the antidegradation policy of the standards. (87)

Response:
These regulations will be very important parts of the Draft EIS discussion.

35. I was a hard rock miner for four years in the construction and start up of the West Fork Mine. Several times during construction of those mines and sinking of those three shafts we ran into between 3,000 and 5,000 gallons of water per minute shooting into the shaft and needing to be pumped out. I know that had to have an effect on water quality because we were pumping out a lot of diesel oil and chemicals along with the water while we were doing those shafts. (41)

Response:
Such incidents have happened at several of the Viburnum Trend mines, though not all. Whether or not similar incidents might happen in the study area is speculative.

36. Lead in this area is about 2,000 feet deep, and there is no danger of surface collapse. The water in the lead formation (Bonneterre) is of drinking quality. Viburnum is using water from a mined-out mine for town use, as is the Town of Bonne Terre. (18)

Response:
These points will be considered in the Draft EIS.

37. Underground tailings storage is an established mining technology. Such storage removes minerals from contact with the atmosphere and prevents their decomposition into heavy-metal compounds with higher biological activity. Groundwater pollution can be eliminated. (16)

Response:
Underground tailings storage undoubtedly would be considered if a mine were proposed.

38. An aquatic vertebrate unique to caves in the region is the southern cavefish (Typhlichthys subterraneus). This species is known from several locations along Hurricane Creek and other nearby locations along the Eleven Point. It's closest relative, the Ozark Cavefish, (Amblyopsis Rosae), is classified as an endangered species in Missouri and is listed as federally threatened. Groundwater contamination of it's very small Missouri range is one of the major causes of decline for the Ozark cavefish. (7)

The fertilizer spill that caused groundwater contamination was catastrophic to aquatic fauna in Meramec Spring in November 1981. Similar types of contamination could have devastating effects on sensitive species within the proposed minerals leases study area. (7)

Response:
Discussion of cave fauna and how they might be affected by mining will be an important part of the Draft EIS.

WILDLIFE

Issues

1. Detrimental impacts to wildlife habitat and populations, including threatened and endangered species, are likely from mining activities. Further evaluation of these potential adverse impacts is needed, especially effects of water quality or quantity changes. (7, 10, 12, 13, 20, 39, 44, 52, 65, 74, 80, 91, 98, 110, 509, 515, 516, 533, 535, 550, 557, 566, 569, 571)

2. Mining will cause no harm to wildlife. (537)

Response:
Possible impacts to wildlife will be evaluated in the Environmental Consequences section of the EIS. Mitigating measures and/or alternatives will be developed, if necessary, to eliminate impacts or reduce impacts to an acceptable level. A Biological Evaluation will also be completed for those species federally-listed as threatened or endangered and will be reviewed by the U.S. Fish and Wildlife Service.

New Information

3. Occurrences of threatened, endangered, rare, or sensitive species were noted and locations given. (7, 110, 532, 533, 534)

Response:
This information has been added to the list of species in the study area.

4. A review of management activities recommended in Gardner's 1982 publication, An Inventory and Evaluation of Cave Resources on the Mark Twain National Forest, was suggested. (7)

Response:
This document will be used as a reference during the analysis of Environmental Consequences and in development of mitigating measures and/or alternatives as appropriate.

5. Information was given on the biological processes by which organisms deal with heavy metals and other contaminants. (16, 28)

Response:
This information will be evaluated in the Environmental Consequences section of the EIS.

LAND CHARACTER

Issues

1. The study area is perceived as being characteristic of the presettlement landscape, special, extraordinary, relatively pristine, unspoiled, a natural garden, beautiful, a natural-appearing ecosystem, a healthy watershed. (21, 51, 98, 103, 520, 530, 543, 544, 548, 550, 551, 552, 555, 556, 557, 559, 563, 567, 571)

Response:
The character of the landscape will be described in the Affected Environment section of the EIS.

2. Special areas with unique natural, recreational, aesthetic, scenic, archaeological, and historic values exist in this area and are of importance to both the state and the nation. Concerns were expressed that mining activities might permanently impair or destroy these values. The Highway 19 recreational corridor should be protected from visual corruption. (7, 12, 24, 44, 57, 78, 80, 98, 109, 110, 111, 112, 113, 114, 118, 119, 515, 516, 521, 525, 527, 543, 551, 552, 559, 562, 567, 569)

Response:
These areas and values will be considered in the Environmental Consequences section

of the EIS. Locations of special areas will be noted and mitigating measures and/or alternatives developed if necessary to protect these resources. Laws, regulations, and Forest Plan standards and guidelines designed to protect these resources will be adhered to.

3. Development and maintenance of powerlines, roads, and other secondary facilities has not been adequately addressed. The possibility of the Fristoe Unit looking like the Viburnum trend would be a disaster the state cannot and should not afford. Soil erosion, air pollution, and noise pollution are possible consequences of mining activities and should not be allowed to occur. (20, 57, 64, 78, 85, 509, 515, 516, 530, 535, 571)

   Response:
   Secondary facilities and their impacts on all resources including land character, soil, and air, will be discussed in the Environmental Consequences section of the EIS. Mitigating measures and/or alternatives will be developed as necessary to keep impacts to an acceptable level. Standards and Guidelines of the Forest Plan, as well as applicable laws and regulations for these resources will apply.

4. Why worry about truck noises and emissions when RV vehicles are worse? (553)

   Response:
   Cumulative impacts on all resources from all activities, mining and non-mining, will be done in the Environmental Consequences section.

5. The effects of mining are temporary and reclamation can return the area to its original condition. (505)

6. Recontouring surface disturbance is sensible, but is merely like putting a bandaid on an amputated limb. (560)

   Response:
   Reclamation methods and standards will be required if any development occurs. Standards will be developed by the Forest Service and BLM at the time development plans are submitted for approval. All such reclamation will be in accordance with mitigating measures developed in the EIS.

NATIONALLY DESIGNATED AREAS

Issues

1. The Eleven Point National Scenic River, Ozark National Scenic Riverways, the Irish Wilderness, Greer Spring, and Cupola Pond have been nationally designated as outstanding resources worthy of protection. Development in this area or pollution of surface or ground waters flowing into these areas through release or escape of mine/mill wastes or silt, or changes in water flow, will 1) destroy the qualities for which these areas have been set aside; 2) endanger the high quality aesthetic and recreational values of the area and the rivers and threaten the considerable income received from tourism; and 3) threaten the fish and wildlife dependent on the rivers and eliminate the use of these resources. (1, 3, 8, 12, 29, 36, 51, 57, 58, 61, 62, 64, 67, 70, 73, 74, 76, 78, 79, 81, 82, 84, 91, 94, 95, 101, 110, 113, 115, 504, 509, 510, 511, 513, 515, 516, 522, 523, 524, 528, 529, 532, 534, 536, 538, 539, 540, 541, 542, 543, 546, 551, 552, 555, 556, 558, 559, 560, 561, 562, 569, 570, 571, 572, 573, 574, 578)

   Response:
   Impacts on these resources will be evaluated in the Environmental Consequences section. Laws, regulations, and Forest Plan standards and guidelines designed to protect these resources will be complied with.

New Information

2. Special Missouri Department of Natural Resources water quality regulations apply to waters of the Eleven Point National Scenic River and Ozark National Scenic Riverways. (30, 31, 85, 87, 109, 573)

   Response:
   All applicable State and Federal laws will be listed in the EIS. The environmental consequences of the proposed action will be evaluated to determine the ability to meet existing laws and regulations. Mitigating measures and/or alternatives will be developed as necessary for those impacts which exceed standards set by these laws and regulations. If impacts cannot be mitigated to meet laws and regulations in effect at the time, development cannot occur.

ECONOMY AND LIFESTYLE

Issues

1. Considerable concern has been expressed in the need for additional jobs and income in the area. Unemployment is high, jobs are scarce, and a large proportion of the population is at or near the poverty level. Families and/or individuals who would rather stay are forced to go elsewhere to find employment. (9, 23, 25, 27, 28, 33, 34, 37, 41, 43, 44, 48, 50, 55, 66, 68, 69, 84, 85, 88, 100, 104, 105, 505, 518, 519, 537, 545, 553, 554)

2. There are serious concerns that increases in employment and income relating to mining operations would be of only temporary duration. Mining could adversely affect the people's lifestyle,

and there are also concerns about the impacts of mining on other industries, such as tourism and recreation. (12, 28, 29, 30, 33, 34, 36, 39, 41, 44, 45, 58, 60, 62, 63, 64, 74, 85, 102, 110, 111, 119, 504, 509, 510, 515, 516, 522, 524, 525, 526, 529, 531, 536, 538, 541, 546, 548, 559, 560, 561, 562, 564, 569, 570, 571, 578)

Response:
In the Environmental Consequences section of the EIS, an analysis will be made of the effects of each alternative on such economic and social factors as population, employment, lifestyles, income, and attitudes, beliefs and values. Where the economic or social impacts of a particular alternative are judged to be significantly adverse, mitigating measures may be developed and new alternatives formulated. In addition, the high level of public response to this issue assures that economic and social factors will be an important consideration in the selection of the preferred alternative.

New Information

3. Information was given on unemployment in the affected counties and potential income from a typical mining operation. An offer to research or substantiate figures was made. (100)

   Response:
   This information will be used to help describe the current economic situation in the Affected Environment section and will also be used in looking at impacts of the proposed action and alternatives. We appreciate the offer of assistance and will call on you as necessary.

LAND USE PURPOSE

Issues

1. There is a concern that mineral production and development in this area is inconsistent with the purpose for which the land was acquired and is therefore contrary to law. (81, 504, 539, 542, 558, 560, 573, 574)

   Response:
   Land use purpose will be considered as part of the Environmental Impacts in the EIS.

MINING INDUSTRY

Issues

1. Why consider lead mining leases when lead prices are low, markets for lead are disappearing, and recycling of lead products is on the rise? Viburnum mines are closed or operating at less than full capacity. Let public lands be the last storehouse of lead for the nation. (14, 28, 44, 51, 55, 64, 85, 104, 111, 112, 113, 114, 115, 510, 522, 531, 534, 535, 538, 558, 564, 569, 571, 578)

2. We should develop and use our own resources and not import lead at high prices. (75, 108)

   Response:
   Mineral uses are a part of Forest Service multiple use management as are other resources such as timber, wildlife, and recreation. Although sufficient quantities of lead to meet demand exist now, the best estimates are that ore in the Viburnum Trend will be nearly depleted by the year 2000. With a lead-in time of at least ten years, it is necessary to find a new field now and begin development of facilities. These factors including market conditions, will be considered in the impacts section of the EIS.

3. Alternate technologies for disposing of mine waste, particularly underground storage, should be considered as part of the EIS. (3, 14, 16, 44, 63, 71, 82, 108)

   Response:
   Although the Proposed Action will address the storage of waste in tailings ponds, other feasible methods of tailings disposal will be considered and evaluated in the alternatives and impacts sections of the EIS.

4. Many questions were asked concerning mining technology which will be used if a mine is developed on the lease areas. Subjects mentioned include reclamation methods, by-products, smelting, number of employees and skill levels, and toxicity of waste products. Experimental or untried technologies should not be used here where the risks are so great. (6, 36, 41, 44, 55, 62, 73, 81, 82, 85, 86, 110)

5. Mining regulations are considerably more strict today than when mining took place in the Old Lead Belt and when it started in the Viburnum Trend. New technologies have been developed and implemented to respond to growing concerns over environmental damage. (14, 71, 75,)

   Response:
   Mining techniques will be explained in the Proposed Action section of the EIS. Impacts of mining methods will be discussed in the Environmental Impacts section. For purposes of this analysis, we are assuming a range of possible mining activities. The range is from a few holes to full Viburnum development. We will also consider alternate mining techniques and assess possible effects to ensure we consider a full range of alternatives.

6. Most commentors expressed an opinion on whether or not the leases should be granted.

Response:
During the scoping stage of the EIS process, identification of public issuesand concerns is the primary purpose. We appreciate knowing how each commentor feels. There will be further opportunity to comment when the draft EIS is published.

New Information

7. Information was given on regulations which may apply to mining operations known reserves lead-in time needed to bring a mine into production, the potential of the area to support ore deposits, and the company's economic considerations. (14, 71, 87, 108)

   Response:
   This information will be used to help describe the Affected Environment and to evaluate impacts in the Environmental Effects section of the EIS.

EIS PROCESS

Issues

1. Responsible company operation and resource protection will depend on the quality and effectiveness of enforcement and monitoring of all activities. Which agencies are responsible for various aspects of control of pollution? Where will the money come from for enforcement and is existing personnel adequate? Are there penalties for non-compliance and are they sufficient to deter pollution? (38, 41, 42, 85)

   Response:
   The purpose of the EIS is to determine the potential effects of mining which may result if a lease is issued. The analysis will identify lease terms and monitoring necessary to ensure protection of other forest resources and uses. If and when mining is proposed, we will do a site specific analysis to ensure that mining will not unacceptably affect any resources. The EIS will include a detailed list of all regulatory agencies and permitting/administrative requirements. Federal regulatory agency funding is provided by Congress. Therefore, the public will pay, through tax dollars, for enforcement. However, industry will pay for mitigation to help reduce any impacts on other resources. A lease can be terminated at any time for failure to meet lease terms. In addition, other agencies will set penalties for non-compliance with their regulations and may revoke permits or levy fines.

2. What provision is there for new regulations or restrictions on discharge and disposal of mining wastes as new information becomes available? (85)

   Response:
   All leases require compliance with all existing, current, and future Federal and State regulations.

3. The proposed activity does not clearly separate the exploration phase from the mining phase. The indication that once this lease is issued the mining company might proceed directly from an exploration phase to a mining phase with little agency or public input as to whether or not effects on environmental or economic resources are acceptable. (91)

   Response:
   In Missouri, on acquired Federal lands such as the Mark Twain National Forest, there are four steps prior to mining: (1) the company must obtain an exploration permit from BLM, (2) the company must have an exploration plan approved by the Forest Service and BLM, (3) the company must apply for and obtain a lease from BLM to develop and produce specific minerals. (This is the stage we are analyzing), (4) the company must have a site-specific mining plan approved by the Forest Service and BLM.

   Each of these steps require full analysis, including public involvement. In addition, the company must obtain all required State & Federal permits prior to beginning development or construction.

4. Does Doe Run or USX have exclusive mining rights? Will mining privileges be offered on a bid basis? (44)

   Response:
   Doe Run has exclusive rights to lease the lands included in the original exploration permits. If they were to withdraw their lease applications and the Bureau of Land Management were to maintain its "valuable discovery" determination, the lands would be available by bid only.

5. What is the potential for USX leasing private land next to or near their claim for waste disposal and tailings ponds, thus circumventing Federal regulations in the lease? (85)

   Response:
   There is no prohibition against companies leasing private lands, for whatever purpose. Their activities on private lands must still comply with the same State water quality/waste disposal requirements as would be enforced on Federal lands. In the Viburnum area, the lessees have exchanged land with the Forest Service so that their facilities, including ponds, are located primarily on their own land.

6. There are concerns that the EIS cannot possibly be completed or adequately cover all issues in the timeframe given. There is also a concern that data needed for the

analysis cannot be collected in the time available. (57, 81, 110)

Response:
The time frame for completion of the analysis and the Draft Environmental impact statement has been extended with a projected completion date of mid-October 1987. At any time, the EIS schedule may be revised to adjust for unforseen circumstances.

7. What are the direct and indirect costs of preparing the EIS? (18)

Response:
The National Environmental Policy Act and Agency regulations require that Federal Agencies prepare an EIS to document the results of Federal actions that may significantly affect the human environment (40 CRF 1502.3). The cost of preparing this document is incorporated into agency budgets as price of doing business.

8. We encourage the BLM and Forest Service to cooperate fully with the National Park Service and US Fish and Wildlife Service in preparing this EIS. (81)

Response:
Both these agencies, as well as several other Federal and state agencies, arecooperating agencies. They are involved at every step of this analysis.

9. Lease money received by USDA should be used to fund independent, scientifically qualified commmissions to determine adequate waste disposal methods. (28)

Response:
75% of all lease rentals and royalties are returned to the U.S. Treasury General Fund. The remaining 25% is returned to local governments when Federal minerals are leased. These funds are not available for specific purposes.

10. Concerns were expressed that the public should continue to be kept informed on this issue and have more opportunity to stay involved. (5, 61, 76, 78, 89, 91, 96)

Response:
The public will have an opportunity to comment on the draft and final EIS before any decisions are implemented. If a lease is issued, there will still be an opportunity to review any operating plans before they are approved.

LIST OF SCOPING PARTICIPANTS

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Chris Levery	2	Bill Cotton	50
J. C. Keesey	3	George A. Behrens	51
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Keith Rauch	6	Bill Weiss	54
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Wiley Cawthra	15	Carl Bassler	63
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Russell B. Bowen	17	Susan Ditson	65
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Lorene C. Love	19	Jim Young	67
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Roseanne Moales	20	Clinton and Barbara Clark	68
Ruth Brandes	21	Velo Hicks	68
Karen Prosser, Mary and Jerry Cox	22	Patricia M. Martin	68
Wayne E. Miley	23	Colleen Roberts	68
Bill and Gaye Pate	24	Rick and Shelly McAfee	68
Chester Howell	25	Gatie Mitchem	68
Kent M. Grewe	26	David and Susan Meade	68
Gordon Buchner	27	Charles and Georgia Wright	68
David G. Hollis	28	Floyd Voyles	68
Monte Phillips	29	Dennis and Ginger Smick	68
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Tom Aley	34	Shannon Jones	68

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Millie Osborne	43
E. Earl Durnell	44
Steve H. Herbst	45
Roy Ross	46
David Hightower	47
David Meade	48
Owen R. Frazier	69
Wayland Bland	69
Wayne Thomason	69
H. D. Harris	69
C. E. Cooly	69
Kit R. Ross	69
Lorene Stinson	69
Thomas K. Stinson	69
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Connie Dixon	69
Beth G. Swank	69
Byron Dailey	69
Bruce Lindsey	69
Patti Kuessner	69
Dennis Bleinkall	69
Golden Bowen	69
Gary Johnton	69
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Ron Hagler	69
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Katy Knight	69
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Galen C. Ford	69
David L. Henry	69
Linda Van Winkee	69
Vickki Grandstaff	69
Mary Blunkall	69
Anita Weaver	69
Carletta Abbey	69
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Nancy Redman	68
Irene Page	68
Dawn Basham	68
Kelly Phillips	68
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Nancy K. Bland	69
Mildred Faust	69
Doyle Simpson	69
Mike Vaughn	69
Rex Vermillion	69
Jeff McAfee	69
Arlena Stoeber	69
Daisy Newcomer	69
Teddy Yates	69
Carol Chrisco	69
Bonnie Saffell	69
Angie Young	69
Sandy Francis	69
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Ruth Seaman	69
Maureen Putman	69
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Ada Brawley	69
Katy S. Biyelli	69
Ray K. Dillion	69
Charlotte Conway	69
James Brewer	69
Frank Stearns	69
Archie Seaman	69
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Allen Comac	69
Sarah Deryberg	69
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Sharon Davis	69
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Christy Craig	69	Ellen C. Walker	69
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Donnie McAfee	69	Shawna R. Wallace	69
Brian Lindsey	69	Mike Manis	69
Gordon Voyles	69	Herbert Walker	69
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Patricia Fisher	69	Gordon A. Williamson	69
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J. C. Blunkull	69	Louis Putman	69
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Tressa Smith	69	Arthur Green	69
Lu R. Price	69	Glen Brown	69
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Kenny Hiehert	69	Raymond Minnich	69
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Charles Purcell	69	Kenneth Tay	69
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Reva Miley	69
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Jerry and Arleen Bland	88
Dale and Opal Redman	88
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Jack Barnes	69
Troy Bland	69
Philipo Wattus	69
Roger T. Rose	69
Darren I. Osborne	69
Mildred Stein	69
Robert Medley	69
Benny Stein	69
Mary Brown	69
Kay and James Hough	69
Wanda and Gerald Martin	69
Dennis VanWinkle	69
Geneva Broder	69
Peggy McAfee	69
Millie Osburn	69
Terry McGride	69
Willard Osburn	69
Carolyn Buckner	69
Shannon Kelly	69
Francis Stein	69
John M. Broder	69
Bill Reed	69
Robbin Norris	69
Billy G. Sanders	69
Donzie Jones	69
Guy Stephens	69
Eula and Jessie Reed	69
Nellie Harrison	69
Estill and Gladys Browning	69
Arthur Young	69
Robbie and Debbie Berry	88
Elsie Patterson	88
Debbie and Melvin Redman	88
Gracie, Floyd, John and James Fox	88
Shirley Barnes	88
Ray C. Jones	88
Inos Yardley	88
Gregg B. Messel	89
Lewis McCann	90
Richard Wehnes, Mo Ch Amer Fish Soc	91
Randal Clark	92
Hank Ottinger	93
Charles Davidson	94
Kay Stewart	95
Roy C. Hengerson	96
John Madras	97
Paul W. Nelson	98
Greg Mihalvich	99
Beverly Livingston	100
Tom Lange	101
Art Sullivan	102
James A. Burris	103
Bill Marbaker	104
Beverly Hollis	105
Dennis Wilson	105
J. C. Kuessner	105
Shearon and Henry Farris	105
Albert and Carolyn Shomaker	105
A. A. Woody	105
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Everett Bland	88
Flora Bland	88
Roy and Kathy Bettis	88
Charley and Jannie Counts	88
Janie and Albert Huett	88
Charles Haynes	88
Mike Manis	88
Christine Haynes	88
Jerry Cooper	88
Geraldine Jones	88
Rita Johnnson	88
Don Johnson	88
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Paul Stupperich	109
C.H.Odegaard,USDI, Natl Park Serv	110
Bruce R. Thomas	111*
Mrs. C. Zalaudek	112*
Marilyn L. Reichmuth	113*
Clinton B. Roberts	114*
Donovan Larson	115*
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JoAnn and Leroy Denning	117*
Bill and Margie Denning	117*
Glenna Buckner	117*
Cindy D. Buckner	117*
Roy and Janet Buckner	117*
Will Rutledge	117*
Jonathan Callahan	118*
Rev. Lawrence B. Lewis	119*
Wink Hastings	501
Harold E. Myers	502
Paul R. Dingess	503
Sierra Club,Legal Defense Fund	504
William H. Grundmann, Jr.	505
Cominco Metals	506
Homestake Lead Co. of Missouri	507
Mining Industry Council of Mo.	508
Grand Gulf Aububon Society	509
East Ozark Audubon Society	510
Public Lands Institute	511
National Water Center	512
National Audubon Society	513
Coalition for the Environment	514
Friends of the Earth	515
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City of Birch Tree	519
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James M. Kellogg	521
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Mrs. Dorothy Ellis	523
Teresa Carel	524
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Anita C. Coats	526
Harold Sdenler	527
Mark Goodman	528
Mr. and Mrs. Richard Glass	529
Frances S. Storlie	530
Kazie Perkins	531
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Bryan Hough	105
Donald Joe Barnes	105
Jess W. and Lauire Steele	105
Tammy and Gary West	105
Kaye and Eugene Brewer	105
Dale Martin	105
Katie and Brock Vermillion	105
Glenda S. Phillips	105
Tracy Lunsford	105
Larry and Charlene Adier	105
Nadine Lunsford	105
Frank Simpson	105
Samuel E. Gamblin	105
Tillman P. Eye	105
Ava Tucker	105
Peggy Gibstine	106
Jeff Tupper	107
Charles C. Cantrell	536
Hardin Franks	537
Drs. Elizabeth and David Hollis	538
M. McKenzie	539
Terry Carel	540
C. Taber	541
Lester Marsh	542
James Paxton	544
Pat Miley	545
Greg Mihalvevich	546
Jacqueline Froelich	547
Julie Jackson	548
Steve and Sharon Henderson	549
Gregory J. Yokum	550
Jane E. Fisher	550
Frank Dohlgrin	550
Donald G. Dunham	550
Eugene A. Degenhardt, P.E.	550
Mike A. Brach	550
Serena L. Crop	550
Mark M. Oliver	550
Sandra S. Tremlsley	550
Pamela F. Saberten	550
James R. Donley	550
E. Howard Matthews	551
Maryelen Dixon	551
Sheli Kay Top	551
Simm Beman	551
David B. Lehmann	551
Yongochen Cheng	551
Hal A. Pyner	551
Jean Ann Gay	551
Margaret Schmidt	552
Melody Davis	552
James D. Marry II	552
Lora L. Johnson	552
Eric D. Dummet	552
Nghiep Hung Tram	552
Debbie Schaehes	552
Rich Phgen	552
Amy L. Schmidt	552
Daniel Staack	553
Gary S. Fowler	554
Kathleen Farrelly	555
Carol Clivio	556
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State of Mo, DNR, Ofc of Dir.	574	Dept Army Little Rock Dst-Crps Eng	575
Dept of Int, Geological Srvy	576	Missouri DNR, Division of Geology and Land Survey	577
Susan Haney	578		

* 111 through 119 are scoping participants who sent their response in after the scoping period, These respondents are not included in Tables 3A, 3B and 3C, but their comments are addressed in the List of Comments and Study Team Responses.

APPENDIX 4

SCIENTIFIC NAMES OF PLANTS

TREES AND SHRUBS

Acer negundo	Boxelder maple
Acer rubrum	Red maple
Acer saccharum	Sugar maple
Asimina triloba	Common pawpaw
Betula nigra	River birch
Bumelia spp.	Gum bumelia
Carpinus caroliniana	Ironwood
Carya spp.	Hickories
Celtis occidentalis	Common hackberry
Cercis candensis	Eastern redbud
Cornus florida	Flowering dogwood
Corylus americana	American hazelnut
Crataegus spp.	Hawthorn
Diospyros virginiana	Common persimmon
Dirca palustris	Leatherwood
Fraxinus americana	White ash
Fraxinus spp.	Ash
Hydrangea arborescens	Wild hydrangea
Juglans nigra	Black walnut
Juniperus virginiana	Eastern redcedar
Lindera benzoin	Common spicebush
Liriodendron tulipifera	Tuliptree
Liquidambar styraciflua	American sweetgum
Nyssa aquatica	Water tupelo
Nyssa sylvatica	Blackgum tupelo
Ostrya virginiana	American hophornbeam
Pinus echinata	Shortleaf pine
Platanus occidentalis	American sycamore
Populus deltoides	Eastern cottonwood
Prunus spp.	Wild cherry
Prunus spp.	Wild plum
Quercus alba	White oak
Quercus coccinea	Scarlet oak
Quercus marilandica	Blackjack oak
Quercus muhlenbergii	Chinkapin oak
Quercus rubra	Northern red oak
Quercus stellata	Post oak
Quercus velutina	Black oak
Rhamnus caroliniana	Carolina buckthorn
Rhododendron roseum	Rose azalea
Sassafras albidum	White sassafras
Staphylea trifolia	Bladdernut
Ulmus rubra	Slippery elm
Viburnum rufidulum	Rusty blackhaw

HERBACEOUS VEGETATION

Ambrosia spp.	Ragweed
Anacharis spp.	Waterweed
Andropogon gerardi	Big bluestem
Andropogon scoparius	Little bluestem
Antennaria spp.	Pussytoes
Arundinaria gigantea	Giant cane
Aster spp.	Aster
Bouteloua curtipendula	Sideoats grama
Callitriche spp.	Water starwart
Camptosorus rhizophyllus	Walking fern
Carex spp.	Sedges
Ceanothus americanus	New Jersey tea
Celastrus scandens	American bittersweet
Cunila origanoides	Dittany
Danthonia spicata	Poverty oatgrass
Desmodium spp.	Tickclover (tick trefoil)
Echinacea spp.	Coneflowers
Helianthus spp.	Sunflowers
Heuchera spp.	Alumroot
Lespedeza spp.	Lespedeza
Liatris spp.	Gayfeather (blazing star)
Monotropa Hypopithys	Pinesap
Myriophyllum spp.	Water milfoil
Nasturtium spp.	Water cress
Nuphar luteum	Pond lily
Oenothera missouriensis	Missouri evening primrose
Panicum spp.	Panic grasses
Polypodium polypodioides	Resurrection fern
Toxicodendron radicans	Common poison-ivy
Rhus aromatica	Fragrant sumac
Rhus spp.	Sumac
Rubus spp.	Blackberry
Saxifraga spp.	Wild saxifrage
Smilax spp.	Greenbriar
Solidago spp.	Goldenrod
Sorghastrum nutans	Indiangrass
Typha latifolia	Common cattail
Vaccinium spp.	Blueberry
Vitis spp.	Grape

APPENDIX 5

OCCURRENCE OF LISTED SPECIES AND SPECIES OF CONCERN - PLANTS

STUDY AREA

Species	Scientific Name	Status 1/	Location	Source 2/
Sedge	Carex decomposita	FP, MO-W		1
False hellebore	Veratrum woodii	FP-T	Greer Spring, Horseshoe Bend	2
Horsetail spike rush	Eleocharis equisetoides	MO-E	Tupelo Gum Pond	1,2,3
Unnamed moss	Helodium paludosum	MO-E	Flat Pond	2
False loosestrife	Ludwiga microcarpa	MO-E	Greer Greer	2,3
Canby's bulrush	Scirpus etuberculatus	MO-E	Tupelo Gum Pond	1,2,3
Swaying rush	Scirpus subterminalis	MO-E	Irish Wilderness	2,3
Arrow-wood	Viburnum recognitum	MO-E	Eleven Point River	2,3
Death camas	Zigadenus Nuttallii	MO-E	Eleven Point River	2,3
Least duckweed	Lemna minima	MO-R	Tupelo Gum Pond	1,2,3
Star duckweed	Lemna triscula	MO-R	Eleven Point River	2,3
Yucca	Yucca glauca var. mollis	MO-R	Irish Wilderness	2,3
Manna grass	Glyceria acutiflora	MO-W	Tupelo Gum Pond	1,2,3

1/ FP, Proposed for Federal listing; FP-T, Proposed for Federal Threatened; MO-E, Missouri endangered: MO-R, Missouri rare; MO-W, Missouri watchlist.

2/ SOURCES

1. Missouri Department of Conservation, 1986.
2. Hornberger, K. and S.W. Morgan, 1980.
3. Missouri Department of Conservation, 1985.

OZARK NATIONAL SCENIC RIVERWAYS AND LOWER CURRENT RIVER PLANTS

Species	Scientific Name	Status 1/	Location 2/	Source 3/
Sedge	Carex decomposita	FP, MO-W		2
Prairie white fringed orchid	Habenaria leucophaea	FP, MO-E		1
Heartleaf plantain	Plantago cordata	FP, MO-W		2,3
Water sedge	Carex aquatilis var. altior	MO-E		1
Cherokee sedge	Carex cherokeensis	MO-E		2
Log fern	Dryopteris celsa	MO-E		1
Hedge hyssop	Gratiola viscidula	MO-E		2
Yellow fringed orchid	Habenaria ciliaris	MO-E		1
Weak rush	Juncus debilis	MO-E		1
Loesel's twayblade	Liparis loeselii	MO-E		2,3
Aster	Aster dumosus strictior	MO-R		2
Tussock sedge	Carex stricta strictior	MO-R		2
Showy lady-slipper	Cypripedium reginae	MO-R		2
Star duckweed	Lemna triscula	MO-R		2
Wild sweet william	Phlox maculata var. pyramidalis	MO R		1
Spike-rush	Eleocharis lanceolata	MO-W		2
Bulrush	Scirpus polyphyllus	MO-W		2
Nut-rush	Scleria verticillata	MO-W		2

1/ FP, Proposed for Federal listing; MO-E, Missouri endangered: MO-R, Missouri rare; MO-W, Missouri watchlist.

2/ Specific locations of all species are contained in the files of the Winona Ranger District, Mark Twain National Forest.

3/ SOURCES

1. Foster, Dave, Ozark National Scenic Riverways, 1986.
2. Hensold, Nancy C., Mark J. Leoschke and Sharon W. Morgan, 386.
3. Missouri Department of Conservation, 1985.

APPENDIX 6
VERTEBRATE SPECIES KNOWN OR SUSPECTED TO OCCUR IN THE STUDY AREA

ELEVEN POINT RIVER WATERSHED

FISH

Bluegill
Bass, Largemouth
Bass, Smallmouth
Carpsucker, River
Chub, Bigeye
Darter, Banded
Darter, Greenside
Drum, Freshwater
Logperch
Minnow, Ozark
Picheral, Chain
Redhorse, River
Sculpin, Mottled
Shiner, Bleeding
Shiner, Rosyface
Silverside, Brook
Studfish, Northern
Sunfish, Green
Topminnow, Black-spotted
Buffalo, Black
Bass, Rock*
Bass, Spotted
Catfish, Channel
Chub, Hornyhead
Darter, Fantail
Darter, Orangethroat
Eel, American
Madtom, Checkered
Minnow, Bluntnose
Redhorse, Black
Redhorse, Shorthead
Shad, Gizzard
Shiner, Ozark
Shiner, Striped
Stoneroller, Central
Sucker, Northern Hog
Sunfish, Longear
Trout, Rainbow
Bullhead, Yellow
Bass, Shadow
Carp, Common
Cavefish, Southern
Chubsucker, Creek
Darter, Gilt
Darter, Rainbow
Gar, Longnose
Madtom, Ozark
Mooneye
Redhorse, Golden
Sculpin, Banded
Shiner, Bigeye
Shiner, Redfin
Shiner, Telescope
Stoneroller, Largescale
Sucker, White
Sunfish, Spotted
Warmouth

AMPHIBIANS

Bullfrog
Frog, Pickerel
Frog, Wood
Newt, Central
Salamander, Dark-sided
Salamander, Longtail
Salamander, Southern Redback
Toad, Eastern Narrowmouth
Treefrog, Gray
Frog, Blanchard's Cricket
Frog, Southern Leopard
Hellbender*
Peeper, Northern Spring
Salamander, Eastern Tiger
Salamander, Marbled
Salamander, Spotted
Toad, Fowler's
Frog, Green
Frog, Western Chorus
Mudpuppy, Red River
Salamander, Cave
Salamander, Grotto
Salamander, Slimey
Toad, Dwarf American
Treefrog, Cope's Gray

MAMMALS

Badger
Bat, Gray
Bat, Keen's
Bat, Red
Beaver
Coyote
Fox, Red
Mink
Mouse, Deer
Mouse, House
Muskrat
Rabbit, Eastern Cottontail
Rat, Norway
Skunk, Spotted
Squirrel, Gray
Vole, Woodland
Bat, Big Brown
Bat, Hoary
Bat, Little Brown
Bat, Silver-haired
Bobcat
Deer, White-tailed
Gopher, Plains Pocket
Mole, Eastern
Mouse, Fulvous Harvest
Mouse, Western Harvest
Opossum, Virginia
Raccoon
Shrew, Least
Skunk, Striped
Squirrel, Southern Flying
Weasel, Long-tailed
Bat, Evening
Bat, Indiana
Bat, Rafinesque's Big Eared
Bear, Black
Chipmunk, Eastern
Fox, Gray
Lemming, Southern Bog
Mouse, Attwater's
Mouse, Golden
Mouse, White-Footed
Pipistrelle, Eastern
Rat, Eastern Wood
Shrew, Short-tailed
Squireel, Fox
Vole, Prairie
Woodchuck

REPTILES

Coachwhip, Eastern
Kingsnake, Speckled
Rattlesnake, Timber
Skink, Five-lined
Snake, Black Rat
Snake, Great Plains Rat
Copperhead, Osage
Lizard, Eastern Collared
Rattlesnake, Western Pygmy
Skink, Ground
Snake, Flathead
Snake, Midland Brown
Cottonmouth, Western
Lizard, Northern Fence
Skink, Broadhead
Skink, Southern Coal
Snake, Graham's Crayfish
Snake, Midland Water

REPTILES - con't

Snake, Northern Redbelly
Snake, Rough Earth
Snake, Rough Green
Snake, Texas Brown
Snake, Western Earth
Snake, Western Ribbon
Snake, Western Worm
Softshell, Midland Smooth
Stinkpot
Turtle, Alligator Snapping
Turtle, Common Snapping
Turtle, Map
Turtle, Mississippi Map
Turtle, Ornate Box
Turtle, Ouachita Map
Turtle, Three-toed Box

BIRDS

Bittern, American
Blackbird, Red-winged
Blackbird, Rusty
Bluebird, Eastern
Bobolink
Bobwhite, Northern
Bunting, Indigo
Cardinal, Northern
Catbird, Gray
Chat, Yellow-breasted
Chickadee, Carolina
Chuck-Will's-widow
Coot, American
Cowbird, Brownheaded
Creeper, Brown
Crow, American
Cuckoo, Black-billed
Cuckoo, Yellow-billed
Dickcissel
Dove, Mourning
Dove, Rock
Duck, Wood
Eagle, Bald
Eagle, Golden
Egret, Cattle
Egret, Great
Egret, Snowy
Finch, Purple
Flicker, Northern
Flycatcher, Acadian
Flycatcher, Alder
Flycatcher, Great Crested
Flycatcher, Least
Flycatcher, Olive-sided
Flycatcher, Scissor-tailed
Gadwall
Gnatcatcher, Blue-gray
Goldeneye, Common
Goldfinch, American
Goshawk, Northern
Grackle, Common Northern
Grebe, Pied-billed
Grosbeak, Blue
Grouse, Ruffed
Harrier, Northern
Hawk, Brpad-winged
Hawk, Cooper's
Hawk, Red-shouldered*
Hawk, Red-tailed
Hawk, Rough-legged
Hawk, Sharp-shinned
Hawk, Swainson's
Heron, Black-crowned Night
Heron, Great Blue
Heron, Green-backed
Heron, Little Blue
Heron, Yellow-crowned Night
Hummingbird, Ruby-throated
Jay, Blue
Junco, Dark-Eyed
Kestrel, American
Killdeer
Kingbird, Eastern
Kingfished, Belted
Kinglet, Golden-crowned
Kinglet, Ruby-crowned
Lark, Horned
Mallard
Martin, Purple
Meadowlark, Eastern
Mockingbird, Northern
Nighthawk, Common
Nuthatch, Red-breasted
Nuthatch, White-breasted
Oriole, Northern
Oriole, Orchard
Osprey
Ovenbird
Owl, Barred
Owl, Eastern Screech
Owl, Great Horned
Owl, Northern Saw-whet
Parula, Northern
Pewee, Eastern Wood
Phoebe, Eastern
Pintail, Northern
Roadrunner, Greater
Robin, American
Sapsucker, Yellow-bellied
Shoveler, Northern
Shrike, Loggerhead
Siskin, Pine
Snipe, Common
Sparrow, American Tree
Sparrow, Chipping
Sparrow, Clay-colored
Sparrow, Field
Sparrow, Fox
Sparrow, Grasshopper
Sparrow, House
Sparrow, Lark
Sparrow, Leconte's
Sparrow, Sharp-tailed
Sparrow, Song
Sparrow, Swamp
Sparrow, Vesper
Starling, European
Swallow, Bank
Swallow, Barn
Swallow, Cliff
Swallow, Tree
Swan, Tundra
Swift, Chimney
Tanager, Scarlet
Tanager, Summer
Teal, Blue-Winged
Teal, Green-winged
Thrasher, Brown
Thrush, Gray-cheeked
Thrush, Hermit
Thrush, Swainson's
Thrush, Wood
Titmouse, Tufted
Towhee, Rufous-sided
Turkey, Wild
Veery
Vireo, Bell's
Vireo, Philadelphia
Vireo, Red-eyed
Vireo, Solitary
Vireo, Warbling
Vireo, White-eyed
Vireo, Yellow-throated
Vulture, Turcky
Warbler, Blue-winged
Warbler, Black and White
Warbler, Cerulean
Warbler, Hooded
Warbler, Kentucky
Warbler, Prairee
Warbler, Swainson's
Warbler, Worm-eating
Warbler, Yellow
Warbler, Yellow-rumped
Warbler, Yellow-throated
Waterthrush, Louisiana
Warbler, Prothonotary
Waxwing, Cedar
Whip-poor-will
Wigeon, American
Wren, Bewick's
Wren, Carolina
Wren, House
Wren, Marsh
Wren, Sedge
Wren, Winter
Woodcock, American
Woodpecker, Downy
Woodpecker, Hairy
Woodpecker, Pileated
Woodpecker, Red-bellied
Woodpecker, Red-headed

CURRENT RIVER WATERSHED

FISH

Bass, Largemouth
Bass, Smallmouth
Bluegill
Buffalo, Black
Carp, Common
Catfish, Channel
Chub, Bigeye
Chubsucker, Creek
DACE, Southern Redbelly
Darter, Blackside
Darter, Cypress
Darter, Gilt
Darter, Johnny
Darter, Saddleback
Darter, Stargazing
Drum, Freshwater
Gar, Longnose
Herring, Skipjack
Lamprey, Least Brook
Madtom, Freckled
Madtom, Tadpole
Minnow, Fathead
Minnow, Pugnose
Paddlefish
Redhorse, Black
Redhorse, Shorthead
Sculpin, Banded
Shiner, Bigeye
Shiner, Emerald
Shiner, Popeye
Shiner, Rosyface
Shiner, Telescope
Shiner, Whitetail
Stoneroller, Largescale
Sucker, Blue*
Sucker, White
Sunfish, Longear
Sunfish, Spotted
Trout, Rainbow

Bass, Rock*
Bass, Spotted
Bowfin
Buffalo, Smallmouth
Carpsucker, Highfin
Catfish, Flathead
Chub, Hornyhead
Chubsucker, Lake*
Darter, Arkansas Saddled
Darter, Bluntnose
Darter, Dusky
Darter, Greenside
Darter, Orangethroat
Darter, Slough
Darter, Stippled
Eel, American
Gar, Shortnose
Lamprey, American Brook
Madtom, Brindled
Madtom, Ozark
Minnow, Bluntnose
Minnow, Mississippi Silvery
Mooneye
Perch, Pirate
Redhorse, Golden
Redhorse, Silver
Sculpin, Mottled
Shiner, Blacktail
Shiner, Golden
Shiner, Redfin
Shiner, Striped
Shiner, Wedgespot
Silverside, Brook
Studfish, Northern
Sucker, Northern Hog
Sunfish, Banded Pygmy
Sunfish, Orangespotted
Topminnow, Blackspotted
Walleye

Bass, Shadow
Bass, White
Buffalo, Bigmouth
Bullhead, Yellow
Carpsucker, River
Cavefish, Southern
Chub, Streamline
Crappie, White
Darter, Banded
Darter, Current River Saddled*
Darter, Fantail
Darter, Harlequin
Darter, Rainbow
Darter, Speckled
Darter, Yoke
Flier
Gar, Spotted
Lamprey, Chestnut
Madtom, Checkered
Madtom, Slender
Minnow, Bullhead
Minnow, Ozark
Mosquitofish
Pickerel, Chain
Redhorse, River
Sauger
Shad, Gizzard
Shiner, Bleeding
Shiner, Ozark
Shiner, Ribbon
Shiner, Taillight
Shiner, Weed
Stoneroller, Central
Sturgeon, Shovelnose
Sucker, Spotted
Sunfish, Green
Sunfish, Redear
Trout, Brown
Warmouth

AMPHIBIANS

Amphiuma, Three-toed
Frog, Bronze
Frog, Southern Leopard
Frog, Wood
Newt, Central
Salamander, Dark-sided
Salamander, Grotto
Salamander, Mole
Salamander, Southern Redback
Toad, Eastern Narrowmouth
Treefrog, Gray

Bullfrog
Frog, Green
Frog, Uplamd Chorus
Hellbender, Ozark
Peeper, Northern Spring
Salamander, Eastern Tiger
Salamander, Longtail
Salamander, Ringed
Salamander, Spotted
Toad, Fowler's
Treefrog, Green

Frog, Blanchard's Cricket
Frog, Pickerel
Frog, Western Chorus
Mudpuppy, Red River
Salamander, Cave
Salamander, Four-toed
Salamander, Marbled
Salamander, Smallmouth
Toad, Dwarf American
Treefrog, Cope's Gray

MAMMALS

Badger
Bat, Gray
Bat, Keen's
Bat, Red
Beaver
Coyote
Fox, Red

Bat, Big Brown
Bat, Hoary
Bat, Little Brown
Bat, Silver-haired
Bobcat
Deer, White-tailed
Gopher, Plains Pocket

Bat, Evening
Bat, Indiana
Bat, Rafinesque's Big Eared
Bear, Black
Chipmunk, Eastern
Fox, Gray
Lemming, Southern Bog

MAMMALS - con't

Mink
Mouse, Deer
Mouse, House
Muskrat
Pipistrelle, Eastern
Raccoon
Rat, Norway
Skunk, Spotted
Squirrel, Gray
Vole, Woodland
Mole, Eastern
Mouse, Fulvous Harvest
Mouse, Meadow Jumping
Opossum, Virginia
Rabbit, Eastern Cottontail
Rat, Eastern Wood
Shrew, Least
Skunk, Striped
Squirrel, Southern Flying
Weasel, Long-tailed
Mouse White-footed
Mouse, Golden
Mouse, Western Harvest
Otter, River
Rabbit, Swamp
Rat, Hispid Cotton
Shrew, Short-Tailed
Squirrel, Fox
Vole, Prairie
Woodchuck

REPTILES

Coachwhip, Eastern
Copperhead, Southern
Lizard, Eastern Collared
Racer, Southern Black
Skink, Broadhead
Skink, Southern Coal
Snake, Broad Banded Water
Snake, Graham's Crayfish
Snake, Midland Brown
Snake, Northern Redbelly
Snake, Rough Earth
Snake, Western Earth
Snake, Western Worm
Stinkpot
Turtle, Map
Turtle, Ouachita Map
Cooter
Cottonmouth, Western
Lizard, Northern Fence
Rattlesnake, Timber
Skink, Five-Lined
Slider, Red-Eared
Snake, Eastern Hognose
Snake, Great Plains Rat
Snake, Midland Water
Snake, Northern Water
Snake, Rough Green
Snake, Western Mud
Softshell, Midland Smooth
Turtle, Alligator Snapping
Turtle, Mississippi Map
Turtle, Three-Toed Box
Copperhead, Osage
Kingsnake, Speckled
Racer, Eastern Yellowbelly
Rsttlesnake, Western Pygmy
Skink, Ground
Snake, Black Rat
Snake, Flathead
Snake, Green Water
Snake, Mississippi Ringneck
Snake, Prairie Ringneck
Snake, Texas Brown
Snake, Western Ribbon
Softshell, Western Spiny
Turtle, Common Snapping
Turtle, Ornate Box
Turtle, Western Chicken

BIRDS

Bittern, American
Blackbird, Rusty
Bunting, Indigo
Cardinal, Northern
Chickadee, Carolina
Cormorant, Double-crested
Crosbill, Red
Cuckoo, Yellow-billed
Dove, Rock
Duck, American Black
Eagle, Bald
Egret, Great
Flicker, Northern
Flycatcher, Olive-sided
Gnatcatcher, Blue-gray
Goldfinch, American
Grebe, Pied Billed
Grouse, Ruffed
Hawk, Cooper's
Hawk, Sharp-shinned
Heron, Great Blue
Heron, Yellow-crowned Night
Junco, Dark-Eyed
Kingbird, Eastern
Kinglet, Ruby-crowned
Martin, Purple
Mockingbird, Northern
Nuthatch, Red-breasted
Oriole, Orchard
Owl, Barred
Owl, Northern Saw-whet
Phalarope, Wilson
Robin, American
Bittern, Least
Bluebird, Eastern
Bunting, Northern
Catbird, Gray
Chuck, Will's Widow
Cowbird, Brownheaded
Crow, American
Dickcissel
Dowitcher, Long-billed
Duck, Ring-necked
Eagle, Golden
Egret, Snowy
Flycatcher, Great Crested
Flycather, Acadian
Godwit, Hudsonian
Goose, Greater White-fronted
Grosbeak, Blue
Harrier, Northern
Hawk, Red Tailed
Hawk, Swainson's
Heron, Green-Backed
Hummingbird, Ruby-throated
Kestrel, American
Kingfisher, Belted
Lark, Horned
Meadowlark, Eastern
Nighthawk, Common
Nuthatch, White-breasted
Osprey
Owl, Eastern Screech
Parula, Northern
Phoebe, Eastern
Sandpiper, Pectoral
Blackbird, Red-winged
BobolinK
Bunting, Painted
Chat, Yellow-breasted
Coot, American
Creeper, Brown
Cuckoo, Black-billed
Dove, Mourning
Dowitcher, Short-billed
Duck, Wood
Egret, Cattle
Finch, Purple
Flycatcher, Least
Gadwall
Godwit, Marbled
Goshawk, Northern
Grosbeak, Rose-breasted
Hawk, Broad-winged
Hawk, Rough-legged
Heron, Black-crowned Night
Heron, Little Blue
Jay, Blue
Killdeer
Kinglet, Golden-crowned
Mallard
Merganser, Hooded
Northern Crackle, Common
Oriole, Northern
Ovenbird
Owl, Great Horned
Pewee, Eastern Wood
Pintail, Northern
Sandpiper, Semipalmated

CURRENT RIVER WATERSHED - con't

BIRDS - con't

Sandpiper, Solitary
Scaup, Lesser
Siskin, Pine
Sparrow, Chipping
Sparrow, Fox
Sparrow, House
Sparrow, Sharp-tailed
Sparrow, Vesper
Swallow, Bank
Swallow, Northern Rough-winged
Swift, Chimney
Teal, Blue-winged
Thrush, Gray-cheeked
Thrush, Wood
Turley, Wild
Vireo, Philadelphia
Vireo, Warbling
Vulture, Turkey
Warbler, Blue-winged
Warbler, Hooded
Warbler, Palm
Warbler, Prothonotary
Warbler, Yellow
Waterthrush, Louisiana
Wigeon, American
Woodpecker, Downy
Woodpecker, Red-bellied
Wren, Carolina
Wren, Sedge
Sandpiper, Stilt
Shoveler, Northern
Snipe, Common
Sparrow, Clay-colored
Sparrow, Grasshopper
Sparrow, Lark
Sparrow, Song
Sparrow, White-throated
Swallow, Barn
Swallow, Tree
Tanger, Scarlet
Teal, Green-winged
Thrush, Hermit
Titmouse, Tufted
Verry
Vireo, Red-eyed
Vireo, White-eyed
Warbler, Black and White
Warbler, Cerulean
Warbler, Kentucky
Warbler, Pine
Warbler, Tennessee
Warbler, Yellow-rumped
Waxwing, Cedar
Willet
Woodpecker, Hairy
Woodpecker, Red-headed
Wren, House
Wren, Winter
Sapsucker, Yellow-bellied
Shrike, Loggerhead
Sparrow, American Tree
Sparrow, Field
Sparrow, Harris
Sparrow, Leconte's
Sparrow, Swamp
Starling, European
Swallow, Cliff
Swan, Tundra
Tanger, Summer
Thrasher, Brown
Thrush, Swainson's
Towhee, Rufous-sided
Vireo, Bell's
Vireo, Solitary
Vireo, Yellow-throated
Warbler, Blackpoll
Warbler, Chestnut-sided
Warbler, Magnolia
Warbler, Prairie
Warbler, Worm-eating
Warbler, Yellow-throated
Whip-Poor-Will
Woodcock, American
Woodpecker, Pileated
Wren, Bewick's
Wren, Marsh

*These species were not listed by the Missouri Fish and Wildlife Information System, but were added as a result of personal knowledge or communication with others knowledgeable of the area.

Source: Missouri Fish and Wildlife Information System, 1986

APPENDIX 7
SCIENTIFIC NAMES OF ANIMALS

BIRDS

Accipiter cooperii	Cooper's hawk
Accipiter striatus	Sharp-shinned hawk
Aegolius acadicus	Saw-whet owl
Aix sponsa	Wood duck
Anas platyrhyncos	Mallard
Anas spp.	Teal
Aquila chrysaetos	Golden eagle
Ardea herodias	Great blue heron
Bonasa umbellus	Ruffed grouse
Bubo virginianus	Great horned owl
Buteo jamaicensis	Red-tailed hawk
Buteo lagopus	Rough-legged hawk
Buteo lineatus	Red-shouldered hawk
Buteo platypterus	Broad-winged hawk
Buteo swainsoni	Swainson's hawk
Butorides virescens virescens	Green heron (eastern)
Capella gallinago	Common snipe
Cathartes aura	Turkey vulture
Colinus virginianus	Bobwhite quail
Corvus brachyrhynchos	Common crow
Cuculidae	Cuckoos
Dendroica cerulea	Cerulean warbler
Dryocopus pileatus	Pileated woodpecker
Falco sparverius	American kestrel
Fulica americana	American coot
Haliaetus leucocephalus	Bald eagle
Hirundinidae spp.	Swallows
Limnothlypis swainsonii	Swainson's warbler
Meleagris gallopavo	Eastern wild turkey
Megaceryle alcyon alcyon	Eastern belted kingfisher
Otus asio	Screech owl
Parula americana	Northern parula warbler
Pandion haliaetus	Osprey
Philohela minor	American woodcock
Podilymbus podiceps	Pied-billed grebe
Protonotaria citrea	Prothonotary warbler
Sayornis phoebe	Eastern phoebe
Seiurus motacilla	Louisiana waterthrush
Strix varia	Barred owl
Tyrannidae spp.	Flycatchers
Zenaidura macroura	Mourning dove

MAMMALS

Canis latrans	Coyote
Castor canadensis	Beaver
Didelphis virginiana	Opossum
Eptesicus fuscus	Big brown bat
Felis concolor	Eastern cougar
Felis rufus	Bobcat
Glaucomys volans	Southern flying squirrel
Lutra canadensis	River otter
Marmota monax	Woodchuck
Mephitis mephitis	Striped skunk
Mustela frenata	Long-tailed weasel
Mustela vison	Mink
Myotis grisescens	Gray bat
Myotis keenii	Keen's bat
Myotis lucifugus	Little brown bat
Myotis sodalis	Indiana bat
Neotoma floridana	Eastern wood rat

MAMMALS - con't

Odocoileus virginianus	White-tailed deer
Ondatra zibethica	Muskrat
Pipistrellus subflavus	Eastern pipistrelle
Procyon lotor	Raccoon
Scalopus aquaticus	Eastern mole
Sciurus carolinensis	Gray squirrel
Sciurus niger	Fox squirrel
Spilogale putorius	Spotted skunk
Sylvilagus floridanus	Eastern cottontail rabbit
Tamias striatus	Eastern chipmunk
Taxidea taxus	Badger
Urocyon cinereoargenteus	Gray fox
Ursus americanus	Black bear
Vulpes vulpes	Red fox

REPTILES

Agkistrodon piscivorus leucostoma	Western cottonmouth
Chelydra serpentina	Snapping turtle
Crotalus horridus	Timber rattlesnake
Elaphe obsoleta obsoleta	Black rat snake
Emydidae Family	Box turtles
Graptemys geographica	Map turtles
Natrix sipedon pleuralis	Midland water snake
Opheodrys aestivus	Rough green snake
Sternotherus odoratus	Stinkpot
Trionyx muticus muticus	Midland smooth softshell turtle

AMPHIBIANS

Cryptobranchus alleganiensis	Hellbender
Eurycea longicauda	Salamander
Eurycea lucifuga	Cave salamander
Necturus maculosus	Mudpuppy
Plethodon dorsalis angusticlavius	Ozark blind salamander
Plethodon glutinosis	Slimy salamander
Plethodon serratus	Salamander
Rana catesbeiana	Bullfrog
Rana clamitans melanota	Green frog
Rana palustris	Pickerel frog
Typhlotriton speleaus	Grotto salamander

FISH

Alosa chrysochloris	Skipjack herring
Amploplites rupestris	Rock bass
Anguilla rostrata	American eel
Aphredoderus sayanus	Pirate perch
Aplodinotus grunniens	Freshwater drum
Catostomidae Family	Suckers
Cottus spp.	Sculpin
Cycleptus elongatus	Blue sucker
Cyprinidae Family	Minnows
Cyprinus carpio	Carp
Dorosoma cepedianum	Gizzard shad
Esox americanus vermiculatus	Grass pickerel

FISH - con't

Esox niger	Chain pickerel
Etheostoma spp.	Darters
Etheostoma caeruleum	Rainbow darter
Etheostoma euzonum	Arkansas saddled darter
Etheostoma euzonum erizonum	Current River saddled darter
Etheostoma flabellare flabellare	Barred fantail darter
Etheostoma spectabile uniporum	Current River orange-throat darter
Hybopsis spp.	Chub
Hybopsis dissimilis	Streamline chub
Hypentelium nigricans	Northern hog sucker
Ictalurus spp.	Bullhead
Lampetra aepyptera	Least brook lamprey
Lepomis spp.	Sunfish
Lepomis cyanellus	Green sunfish
Lepomis gulosus	Warmouth
Lepomis magalotis	Longear sunfish
Lepomis punctatus miniatus	Spotted sunfish
Micropterus dolomieui	Smallmouth bass
Micropterus salmoides	Largemouth bass
Moxostoma spp.	Redhorse
Moxostoma duquesnei	Black redhorse
Notropis fumeus	Ribbon shiner
Notropis galacturus	Whitetail shiner
Notropis greenei	Wedgespot shiner
Notropis nubilus	Ozark minnow
Notropis ozarcanus	Ozark shiner
Notropis telescopus	Popeye shiner
Notropis venustus	Blacktail shiner
Notropis zonatus	Bleeding shiner
Noturus albater	Ozark madtom
Noturus flavetor	Checkered madtom
Polyodon spathula	Paddlefish
Salmo gairdneri	Rainbow trout
Scaphorhynchus platorynchus	Shovelnose sturgeon
Stizostedion canadense	Sauger
Stizostedion vitreum	Walleye
Typhlichthys subterraneus	Southern cavefish

APPENDIX 8
VERTEBRATE AND INVERTEBRATE CAVE SPECIES

INVERTEBRATES	NO. FOUND
Orders (not identified to family and species)	
Coleoptera	24
Collembola	8
Diptera	41
Hemiptera	1
Hymenoptera	4
Opiliones	1
Psocoptera	2
Thysanura	1
Trichoptera	1
Families (not identified to species)	
Elateridae	1
Erigonidae	1
Ichneumonidae	2
Ichthoniidae	1
Leiodidae	1
Polygyridae	1
Scolytidae	1
Species	
Aleochara glenorana	1
Aleochara spp.	1
Amoebaleria defessa	2
Apheloria corrugata	1
Arrhopalites pygmaeus	2
Atheta spp.	1
Auturus spp.	1
Bradysia spp.	1
Caecidotea antricola	4
Cambarus hubrichti	1
Centromerus latidens	1
Ceuthophilus gracilipes	3
Ceuthophilus williamsoni	7
Conotrachelus posticatus	1
Crangonyx forbesi	2
Crangonyx spp.	1
Cryptophagus distinguendus	1
Cylisticus convexus	1
Deltochilum gibbosum	1
Dolomedes spp.	1
Erichsonius spp.	1
Folsomia candida	1
Fontigens aldrichi	1
Gerris canaliculatus	1
Grammonota spp.	2
Heleomyza brachypterna	1
Hesperochernes occidentalis	2
Hesperochernes spp.	2
Ixodes banksi	1
Lathrobium spp.	1
Lepidostoma spp.	1
Leptocera tenebrarum	4
Ligidium spp.	2
Lirceus spp.	2
Mesodon inflectus	4
Microvelia americana	1
Narceus Americanus	2
Onthophagus cavernicollis	1
Onthophagus orpheus	2
Onychiurus relectus	1
Physa spp.	7
Platynus spp.	11
Pseudoscorpion	3
Pseudosinella spp.	1
Pseudosinella violenta	1
Pseudpolydesmus spp.	1
Ptomaphagus cavernicola	2
Quedius erythrogaster	2
Sabacon cavicolens	1
Stygobromus spp.	1
Tingupa Pallida	5
Tomocerus flavescens	13
Tomocerus lamelliferus	1
Amphipod common	4
Centipede common	1
Crayfish common	2
Cricket common	11
Isopod common	5
Leech common	2
Milliped common	4
Mite common	5
Silverfish common	1
Snail common	12
Spider common	14
Unidentifiable	1
Unknown	7

NEW SPECIES

Stygobromus (amphipod)
Pseudosinella (springtail)

VERTEBRATES Scientific Name	Common Name
Castor canadensis	Beaver
Cathartes aura	Turkey vulture
Crotalus horridus	Timber rattlesnake
Emydidae family	Box turtle
Eptesicus fuscus	Big brown bat
Marmota monax	Groundhog
Myotic lucifugus	Little brown bat
Myotix grisescens	Gray bat
Neotoma floridana	Eastern wood rat
Peromyscus spp.	Mouse
Pipistrellus subflavus	Eastern pipistrelle
Procyon lotor	Raccoon
Rana catesbeiana	Bullfrog
Rana palustris	Pickerel frog
Sayornis phoebe	Eastern phoebe
Sylvilagus floridanus	Cottontail rabbit
Typhlythys subteranneaous	Southern cavefish

Source: USDA-Forest Service, 1978-1982.

APPENDIX 9

THREATENED AND ENDANGERED SPECIES - BIOLOGICAL ASSESSMENT

INTRODUCTION

This biological assessment: 1) provides a list of threatened and endangered species; 2) describes the habitat, distribution, and status of listed species; 3) discusses the effects and consequences of the proposed action and alternatives to the proposed action on the listed species; and 4) recommends modifications of management practices if aspects of the proposal are inconsistent with the recovery objectives for the listed species.

Federal law prohibits Federal agencies from authorizing any project or program that would jeopardize the continued existence of a threatened or endangered species. This biological assessment is the vehicle for determining effects on the listed species. A determination of "may adversely affect" via this evaluation will be resolved through formal consultation with the U.S. Fish and Wildlife Service. The Fish and Wildlife Service's biological opinion will contain a determination of "jeopardy/non-jeopardy" effect on listed species.

This evaluation is being done to analyze the effects of proposed hard-rock mineral leasing on the Winona Ranger District of the Mark Twain National Forest. Two Preference Right Lease applications for 3,743 acres were filed by USX, formerly U.S. Steel Corporation, in November of 1983 after their two prospecting permits had expired. Drill holes done under the permits revealed sufficient lead-zinc mineralization to indicate the presence of a possible mineable deposit. USX has assigned all rights to these lease applications to St. Joe Minerals Corporation, now Doe Run Corporation.

After preparation of a draft environmental analysis, the Forest Service and Bureau of Land Management decided to prepare an Environmental Impact Statement. This decision was based on issues raised by the public and the need to expand the area under analysis to include adjacent areas that may be the subject of future lease applications. The study area, as shown in Figure A, includes 119,000 acres on the Winona, Van Buren, and Doniphan Ranger Districts of the Mark Twain National Forest.

Because a lease conveys the right to develop and produce Federal minerals, the analysis of the proposed action considers all possible environmental effects of a full range of mineral activities. These activities range from Exploration only (enough drilling is done to determine that there is no ore body or there is an unmineable ore body so no further activity takes place) to Low Development (one mine/mill and associated facilities are developed) to High Development (full area development similar to the Viburnum Trend). If a lease is issued, site and activity specific operating plans must be submitted by the company and approved by the Bureau with concurrence from the Forest Service before any activity can begin. In addition, numerous federal and state regulations must be satisfied before surface disturbing activities will be permitted.

Several alternatives to the proposed action have been developed. Alternative A is the No Action alternative where no lease would be issued. Alternative B is Full Leasing to provide maximum mineral development and production. The purpose of this alternative is to analyze the adverse impacts which could result from implementation of standard mining practices currently used in the Viburnum Trend. Alternative C describes how current Forest Plan implementation would affect mineral development and production in the study area. Alternative D establishes new visual quality standards to provide for reasonable mineral development and to minimize unacceptable impacts to land character as measured by visual quality. Alternative E changes the existing management prescription of one management area to permit increased road densities and mineral development. Alternative F combines Alternatives D and E. The impacts of all alternatives on Federally listed species will be considered in this evaluation.

LISTED SPECIES AND HABITAT DESCRIPTIONS

Federally listed species within the study area and Federally listed species outside the study area which could be affected by the proposed action will be the subjects of this biological evaluation. There is no designated critical habitat for any species in the study area as per Fish and Wildlife Service letter of 6/28/86. In the study area, there are no plant species listed by the 1973 Endangered Species Act, but there are two candidates for listing in the area and two additional candidates within the Ozark National Scenic Riverways (ONSR) which could be affected by the proposed action. The species and their classified status are listed at the top of the next page.

Bald eagle - Haliaetus leucocephalus

Although there are no known nesting territories in the study area, the possibility exists that eventually bald eagles will be permanent residents in the study area. A reintroduction program has been in progress in southeast Missouri for six years (Wilson, Jim D. personal communication). In 1983, successful nesting eagles were reported in Missouri for the first time since 1960.

Bald eagles winter along the Eleven Point National Scenic River and the Ozark National Scenic Riverways from December through April.

Species	Classification	Status*
Bald Eagle	Endangered	Winter resident - reintroduction in progress in SE MO
Blue sucker	Proposed	Occurs in Current River
Carex decomposita	Proposed	1 location study area, 1 location ONSR
Eastern cougar	Endangered	Possibly extirpated
False hellebore	Proposed	3 locations study area
Gray bat	Endangered	Resident
Heartleaf plantain	Proposed	35 locations ONSR
Indiana bat	Endangered	Resident
Ozark cavefish	Threatened	Unknown in study area - occurs in caves SW MO
Prairie white-fringed orchid	Proposed	Several locations ONSR

* Known locations for all species are in confidential files at the Winona Ranger District Office.

They also occasionally forage within the watershed of the study area.

In the past five years, the number of eagles reported along the Eleven Point River has ranged from nine (1986) to twenty (1982). Figure BA1 shows eagle observations along the Eleven Point and Current Rivers for 1982 - 1986.

The availability of fish in the open water of the rivers and impoundments is the major attractant for the eagles. Fish are the preferred food, but small mammals, birds, reptiles, amphibians, and carrion are all taken[1]. Fish that use shallow water are most susceptible to eagle predation.

Bald eagles are monogamous and mate for life. Birds reach sexual maturity at around five years old. The adults defend their breeding territory which can range from 20-120 acres, usually near water. Nests are made of grass, twigs and sticks high in a tree, and may be reused year after year. Eggs are laid in April, with one brood of 1-4 young produced each year. Both parents care for the young. A nest may be deserted by the parents following disturbance.

Eagles arrive in their winter territory around December. They roost singly or in small groups in tall trees or on cliffs. Most birds leave for breeding territories by March or April.

The primary reasons for decline of the bald eagle population in the United States are: 1) shooting, electrocution, poisoning, disease, and various types of human disturbance, 2) habitat loss, and 3) reduced reproduction due to environmental contaminants.

[1] All life history information for the bald eagle comes from the Missouri Fish and Wildlife Information System.

Gray bat - Myotis grisescens

Gray bats, which depend on highly specific cave conditions, have been recorded from three caves in the study area and two caves adjacent to the study area (Gardner and Gardner, 1982. and Missouri Department of Conservation, 1985). Locations for these caves are on file at the Winona Ranger District office. Approximately 7,500 individuals use the one known maternity cave south of the study area and approximately 6,500 use the two known transient or bachelor caves, one south of the study area and one within the study area (Gardner and Gardner, 1982). Whether the bats use the other two caves as transient, bachelor, hibernation, or maternity caves is unknown. As well as can be determined, past populations in these individual caves ranged from 13,000 to 91,500 (Gardner and Gardner, 1982).

In addition, gray bats are also known to use eleven caves along the Ozark National Scenic Riverways. One is a known maternity cave, two are possible maternity caves, two are known hibernacula, two are possible bachelor caves, seven are known transient caves, and one is a possible transient cave (Gardner and Taft, 1983 and Clawson, personal communication).

With few exceptions, gray bats use caves exclusively year-round (Evans, 1985/Missouri Fish and Wildlife Information System/U.S. Fish and Wildlife Service, 1982). Different types of caves are preferred depending on season and intended use. Winter caves (hibernacula) act as cold air traps, while summer maternity caves are chosen for their ability to retain body heat from thousands of clustered bats and their close proximity to rivers or reservoirs (Evans, 1985 and U.S. Fish and Wildlife Service, 1982). Preferred temperatures in maternity caves range from 59-82 degrees F. and humidity ranges from 82-100%, with an average of 94.5% (Missouri Fish and Wildlife Information System). Hibernacula range from 40-51 degrees F. with an average of 47.7, and humidity ranges from 75-96% with an average of 83.9% (Missouri Fish and Wildlife Information System). Transient caves, used in spring and fall during migration, have temperatures ranging from 52-63 degrees F. with an average of 58.4, and humidity of 72-95% with an average of 87.5% (Missouri Fish and Wildlife Information System). Because of these specific requirements, less than 5% of the available caves are suitable for gray bat use (U.S. Fish and Wildlife Service, 1982).

In Missouri, the estimated past population of gray bats was about 1,250,000 in 41 maternity caves, primarily in the Ozarks (U.S. Fish and Wildlife Service, 1982). By 1985, only 27 of those caves were still occupied with an

estimated population of 397,800 bats (Clawson, personal communication). Human disturbance is the primary cause for decline of gray bat populations (U.S. Fish and Wildlife Service, 1982). Gray bats congregate in large numbers and few places. This makes them extremely susceptible to disturbance and vandalism. Disturbance in maternity caves may cause adult females to fly and the flightless young to fall to their deaths. Disturbance during hibernation causes the bats to awaken, using valuable fat reserves. It has been estimated that each arousal causes a bat to use 20-30 days of fat reserve (Daan, 1973 in U.S. Fish and Wildlife Service, 1982). Too much disturbance can cause the bats to leave hibernation before adequate food supplies are available and they will starve to death.

Other possible causes of population decline include: pesticide poisoning, pollution or siltation of water over which the bats forage resulting in decline of favored food species, clearing of forested areas near caves and waterways, flooding of caves by impoundments, cave commercialization, improper gating, alteration of cave entrances, and natural disasters such as flooding or cave-ins (U.S. Fish and Wildlife Service, 1982). Accidental collisions with TV tower guy lines have been recorded. Natural predators include mink, raccoon, and opossum (Elder and Gunier, 1980). Black snakes may climb to bat clusters where cave structure is favorable and Chuck-will's-widows may take bats on the wing as they do birds (Elder and Gunier, 1980).

Gray bats migrate between hibernating and summer caves and can range from 10 miles to over 300 miles (U.S. Fish and Wildlife Service, 1982 and Tuttle, 1976 in Evans, 1985). During the summer, about 25% of the world's population of gray bats is in Missouri. In winter, about 20% of the world's population hibernates here (Clawson, personal communication). Statewide population, based on hibernation census figures, is estimated to be 484,200 (Clawson, personal communication).

Hibernation begins in early September and most bats are hibernating by early November. Adult females are the first to emerge in late March, and all bats are active by mid-May. Bats migrate to traditional summer ranges which can be up to 40 miles of river border and include several caves (Evans, 1985 and U.S. Fish and Wildlife Service, 1982).

They become sexually mature at 2 years old (Missouri Fish and Wildlife Information System). Females store sperm throughout the winter, become pregnant after emerging from hibernation, and give birth to a single young in late spring and early summer (Evans, 1985/Missouri Fish and Wildlife Information System/U.S. Fish and Wildlife Service, 1982). Mothers and young inhabit maternity caves while males and nonreproductive females gather in smaller groups in other caves within the home range (U.S. Fish and Wildlife Service, 1982). Larger maternity colonies produce faster growing young than small colonies. This is because larger numbers generate more heat, so individual bats spend less energy keeping warm and more energy can go into growth (Herreid, 1963;1967 and Tuttle, 1975 in U.S. Fish and Wildlife Service, 1982).

Gray bats are opportunistic feeders and forage above permanent water along forested rivers or impoundments (Evans, 1985/LaVal et al. 1977/Missouri Fish and Wildlife Information System). The bats are active at dusk, dawn, and at night. On moonlit nights, they will forage under the trees adjacent to streams. Mayflies are the preferred food, but other insects are taken as well (Missouri Fish and Wildlife Information System and Tuttle, 1976 in Evans, 1985). Beetles are an important food for juveniles in late summer (Missouri Fish and Wildlife Information System).

Growth rates for young bats are directly proportional to the distance of caves from foraging areas (Tuttle, 1976 in U.S. Fish and Wildlife Service, 1982). The closer the cave to the food source, the better the young bats grow. There must be a forested corridor from the cave to the water and along the water to provide protective cover.

Indiana bat - Myotis sodalis

Like gray bats, Indiana bats have very specific cave conditions which they can tolerate. These bats have been recorded from one cave adjacent to the study area and eight caves along the Ozark National Scenic Riverways (Missouri Department of Conservation, 1985 and Gardner and Taft, 1983). Six of the latter are minor hibernacula with less than 1000 bats using the cave, and with some disturbance. Two are major hibernacula with over 1000 bats using them, and with very little disturbance (Gardner and Taft, 1983). One of these has an estimated past population of about 75,000 (Clawson, personal communication). Indiana bats have been reported from the cave adjacent to the study area, but no estimate of population is available.

The statewide population of Indiana bats, from hibernation census figures, is estimated at 223,000 (Clawson, personal communication). The total known population of Indiana bats is estimated at less than 500,000 (Clawson, personal communication). Thus, nearly half the current world population winters in Missouri's Ozarks.

The primary cause of decline of the Indiana bat is believed to be human disturbance (U.S. Fish and Wildlife Service, 1983). When bats are disturbed during hibernation, they arouse using up valuable fat reserves. If this happens often enough, the bats may leave the cave before adequate food is available and starve to death. Bats also have been deliberately killed (U.S. Fish and Wildlife Service, 1983).

Habitat destruction through stream channelization and clearing of forests along streams also may be a major cause of population decline (U.S. Fish and Wildlife Service, 1983).

Flooding of occupied caves, ceiling collapse of mines, and freezing to death in winter are all natural causes of mortality (U.S. Fish and Wildlife Service, 1983). Predators of Indiana bats include owls, snakes, raccoons, mink, and opossum. Other reasons for decline include collecting and handling of bats, commercialization of caves, poorly designed gates or other structures, and changes in cave climate due to opening or closing of alternate entrances (U.S. Fish and Wildlife Service, 1983).

Mature forests which overhang streams seem to be the optimal habitat for Indiana bats in summer (U.S. Fish and Wildlife Service, 1983). Upland forests also may be used (Missouri Fish and Wildlife Information System). Caves are used for hibernation.

Hibernation begins in October, with males remaining active in order to mate with arriving females (Missouri Fish and Wildlife Information System). Strong loyalty is shown toward traditional hibernation caves (Mohr, 1975). Caves used in winter are usually 37-43 degrees F. with humidity above 74% (Clawson, et al. 1980 and Missouri Fish and Wildlife Information System). The bats will congregate in the deeper sections first, and will move to cooler areas, usually nearer cave entrances, as temperatures drop (Missouri Fish and Wildlife Information System). Hibernating clusters of Indiana bats may contain up to 300 bats per square foot (Engel et al., 1976 and Clawson et. al., 1980 in U.S. Fish and Wildlife Service, 1983). Individuals become active periodically during hibernation. Hibernation ends in March or April (U.S. Fish and Wildlife Service, 1983).

Pregnant females may choose hollow trees, but primarily use space beneath loose bark of trees as maternity colonies (Missouri Fish and Wildlife Information System and U.S. Fish and Wildlife Service, 1983). Maternity colonies are found mostly in riparian or floodplain areas near small to medium-sized streams. Roost trees need to be greater than 9" DBH (Missouri Fish and Wildlife Information System). One young is born in late June to early July. Maternity colonies may be 25-100 adults (Missouri Fish and Wildlife Information System).

Indiana bats are active at night, foraging in heavily wooded areas near permanent water, usually on hillsides or ridgetops (LaVal et al. 1977 and Missouri Fish and Wildlife Information System). Foraging usually takes place at 6-30' above ground under the canopy or in the crowns of trees (Missouri Fish and Wildlife Information System). Males may establish feeding territories (Missouri Fish and Wildlife Information System). Moths, butterflies, and aquatic insects are primary food sources (Missouri Fish and Wildlife Information System).

Lifespan may be as much as 15 years for females and 14 years for males (Missouri Fish and Wildlife Information System).

Eastern cougar - Felis concolor

Despite occasional reports of a "black panther" or "big cat", there is no verifiable evidence that cougars still exist in or adjacent to the study area. There have been confirmed reports of mountain lions in adjoining and second-tier counties in Arkansas and Oklahoma, and it is possible that some animals have moved into Missouri (Wilson, 1984). In the past three years, there have been two fairly reliable eyewitness accounts of cougars along the Ozark National Scenic Riverways, but no evidence (tracks, scat, kills) was found. It is generally believed that cougars were extirpated from the area by about 1927 (Missouri Fish and Wildlife Information System and Wilson, 1984).

Cougars were found in all forest types and size classes, but were most common in areas with an abundance of early successional stages (Missouri Fish and Wildlife Information System). Rocky, rugged terrain which is relatively inaccessible and has dense cover is preferred habitat. Although they do not have permanent dens, rock crevices, hollow trees and logs, holes in banks, tall grass and underbrush are all used as shelter (Missouri Fish and Wildlife Information System).

Home range size varies depending on sex, season, food supply, and quality of habitat. Female home ranges are usually 5-30 square miles, while male home ranges are usually 25-35 square miles (Missouri Fish and Wildlife Information System). Home ranges of females may overlap, but generally animals avoid each other unless they are seeking a mate (Missouri Fish and Wildlife Information System).

Breeding takes place year round, but most litters are born from June to September (Missouri Fish and Wildlife Information System). A litter consists of 1-6 young who may stay with the female until they are two years old. There is only one litter per year and the female is the only parent which provides care for the young (Missouri Fish and Wildlife Information System).

Deer are favored prey of cougars and one animal may eat 35 deer per year (Missouri Fish and Wildlife Information System). Man now fills the cougar's previous role of a natural check on the deer population. Small mammals, cattle, and sheep are also eaten. If all prey is not eaten immediately, it is concealed and eaten later. Spoiled meat will not be eaten.

The greatest cause of death is deliberate shooting or vehicle collisions (Missouri Fish and Wildlife Information System). Accidents, disease, and parasites can sometimes be fatal.

Mountain lions tend to select home ranges where human disturbance is limited. Most activity is during mid-evening and around sunset with another peak of activity just before sunrise (Van Dyke et al. 1986). This reduces the likelihood of human-animal contact.

The 186 square mile study area could provide suitable habitat for reintroduction of this species. With a home range of 30 square miles, six animals potentially could reside within the area. Although mostly forested, there is a good percentage of young age classes to provide dense cover. Deer and small mammals are relatively abundant in the area. The Eleven Point River and other smaller drainages provide rugged terrain. The 16,500 acre Irish Wilderness is adjacent to the study area.

The major problem with a reintroduction is the potential for human-animal conflicts. Woods roads provide access to most parts of the study area, increasing the possibility for disturbance of the animals. Continuing human presence in the study area may render it unsuitable for reintroduction even though habitat is available. In addition, there is likely to be substantial local opposition to introducing a potential threat to livestock.

Ozark cavefish - Amblyopsis rosae

There are no known records of Ozark cavefish in caves of the study area. Most known occurrences are in southwest Missouri, over 100 miles from the study area (Pflieger, 1975 and Willis, 1986). However, less is known about the distribution and abundance of cavefish than any other fish in Missouri (Pflieger, 1975).

All of the caves which contain Ozark cavefish have some sort of comparatively large energy source such as bat guano or washed in leaf litter (Willis, 1986). These fish prefer cold water with temperatures less than 70 degrees F., a pH of 7.5 (+/- .5), dissolved oxygen 7-10 mg/l, total alkalinity of 100 mg/l (+/- 25 mg/l), and rubble as the bottom type (Missouri Fish and Wildlife Information system).

Destruction of habitat, collecting, disturbance by spelunkers, and a lack of reproduction are the factors which have most likely contributed to the rarity of this species (Willis, 1986). It seems that Ozark cavefish are dependent on bat guano, particularly of the endangered gray bat, for their energy source (Willis, 1986). Any disturbance which results in reduction of gray bat colonies or abandonment of caves also may severely impact Ozark cavefish.

The Ozark cavefish is one of the most cave adapted vertebrates known, with external sense organs located all over the head, body and fins (Pflieger, 1975). It is found in cave streams, spring outlets, and wells (Missouri Fish and Wildlife Information System). Cavefish first reproduce when 3-4 years old (Missouri Fish and Wildlife Information System). It has been estimated that only 20% of mature females spawn in a given year (Willis, 1986).

They are bottom feeders, picking through the mud, silt, sand or rubble for plankton, small shrimp, crayfish, copepods and other crustaceans, and larva of salamanders, newts, mudpuppies, sirens, and hellbenders (Missouri Fish and Wildlife Information System and Pflieger, 1975). Copepods make up 70-90% by volume of their diet and food seems to be a limiting factor (Missouri Fish and Wildlife Information System).

Blue Sucker - Cycleptus elongatus[2]

The blue sucker is a native of Missouri and is found in deep channels of large rivers and tributaries, including the Current River. Although rare, it is widespread in the Missouri and Mississippi rivers. It can tolerate high turbidity as long as the current is strong enough to prevent sedimentation of the bottom.

The elongated body and sickle-shaped fins are designed to help the fish maintain its place in swift-flowing currents. Food for blue suckers is aquatic insects, insect larvae - including caddisflies, mayflies, midges, flies, mosquitoes, and gnats - and other small bottom invertebrates, such as shrimp, crayfish, and crabs. Spring and fall runs of blue suckers used to occur in the Mississippi River. Spawning is thought to take place in May and June, but adults in breeding condition have been taken from the Current River as early as February. Males mature at about age 4, while females generally mature at age 6.

Considered one of the best food fish of all the suckers, the blue sucker was of minor commercial importance along the big rivers. It continues to be taken in small numbers by commercial fishermen.

2 All information on the blue sucker is from Missouri Fish and Wildlife Information System and Pflieger, 1975.

A sedge - Carex decomposita[3]

This plant is known only from sinkhole ponds in the southeastern Ozarks and in swamps of southeast Missouri. It is found at one location in the study area and one location within the boundaries of the Ozark National Scenic Riverways. It is at the western edge of its range, but is not common anywhere. Habitat destruction, by draining and filling of the sinkhole ponds where it grows, may be responsible for its rarity.

This sedge forms dense large leafy mounds usually in shallow water. Flowers appear from April to July.

Sedges provide an important step in succession - they form a sort of turf in shallow water where other less water-loving plants can establish a foothold and start the natural conversion from open water to climax community. Sedges also provide nest sites for ground-dwelling birds, cover for small mammals and birds, insect habitat, and food for birds, deer, rabbits, and other herbivores.

Heartleaf plantain - Plantago cordata[4]

Habitat for this plant includes shaded or semi-shaded rocky stream beds, headwater streams, wet woods, and along sloughs and spring branches. The plant is found in 35

locations in the Ozark National Scenic Riverways. These areas must be free from siltation and are usually dry during some part of the year. Historical range is from Ontario, New York, and Michigan south to Georgia, Alabama, and Missouri. In Missouri it is more widely distributed than in any other state.

Heartleaf plantain is very sensitive to habitat changes. Destruction of habitat is primarily responsible for the loss of populations. Establishment of new populations is uncommon because seeds have a short dormancy period and are adapted only to water dispersal. This means that seedlings must be established within a few weeks of being shed and that rainfall must occur soon after seeds are shed to transport them to other locations. Also, fewer seeds per plant are produced by this plantain than by any other species of plantain.

False hellebore - Veratrum woodii[5]

This member of the Lily family usually occurs on north or east-facing wooded limestone slopes. It is currently found in three locations in the study area. Flowering seems to be very irregular, with only a small percentage of plants bearing flower stalks in any one year.

Prairie white-fringed orchid - Habenaria leucophaea[6]

Spring-fed calcareous meadows along streams, wet prairies, bogs, marshes and swamps are the habitat for this perennial plant. Flowering occurs in June through July. It is found in several locations throughout Ozark National Scenic Riverways.

3 All information on Carex decomposita is from Steyermark, 1981 and Hensold et al. 1986.
4 All information on heartleaf plantain is from Hensold et al. 1986 and Morgan, 1984.
5 All information on false hellebore is from Hornberger and Morgan, 1980 and Steyermark, 1981.
6 All information on prairie white-fringed orchid is from Morgan, 1984 and Steyermark, 1981.

ALTERNATIVE A - NO ACTION

Bald Eagle

The midwinter eagle survey will be continued to provide data on population numbers. The Missouri Department of Conservation will continue with the eagle hacking program and will monitor the state for nesting eagles.

Management activities in the Eleven Point National Scenic River zone will be limited to recreation facility maintenance and those projects necessary to insure public safety. Vegetation manipulation within the river zone may be done only for perpetuation and maintenance of endangered species habitat. Because of this protection, natural succession will take place and will result in larger, older trees along the river. Small openings will occur where overmature trees die or are uprooted.

Bald eagles will continue to find good roosting habitat in the large trees and along the bluffs of the Eleven Point. Water quality should remain high, resulting in stable or increasing fish populations. A good food source for the wintering eagles will be available, and it is highly likely that eagles will continue to use the Eleven Point River for wintering.

Should nesting eagles be discovered in the study area, Forest Plan standards and guides call for a buffer zone around the nest, where activities which might disturb the birds are prohibited.

There is a continued low likelihood that bald eagles may be accidentally or deliberately shot in the study area.

Gray bat

Management plans for all known gray bat caves will be developed following guidelines in Gardners' Cave Resource Inventory of the Mark Twain, the Gray Bat Recovery Plan, and in Forest Plan standards and guides. The forested nature of the Eleven Point River and other permanent streams in the area is assured by the Forest Plan requirement that riparian areas within 100 feet of permanent water be allowed to revert to natural vegetation and management activities permitted only if they are not detrimental to the establishment and protection of the overall riparian ecosystem and adjacent aquatic ecosystems.

In addition, a corridor of at least 100 feet wide will be maintained between known bat caves and foraging areas. Pesticides, except for incidental housekeeping purposes (i.e. for general maintenance, health, or comfort around buildings, vehicles and areas of concentrated public use), will not be used in the surface and known subsurface watershed of caves containing Federal or state listed species.

Disturbance from cave explorers is possible in bat caves unless gates or other restrictive devices are in place. Currently, only one of the three caves in the study area is gated. This cave is recommended for year-round closure because of the presence of significant geological and natural history values. One of the other caves is on the Eleven Point River and has a very small entrance. It would be very difficult to restrict access to this cave without destroying the aesthetics of the entrance, attracting more attention to the entrance, or altering the entrance so that it was unuseable to the bats. This cave has been recommended for closure from September 1 through April 30 and from April 1 through October 31 if further study indicates that bats use the cave as a maternity roost. There are no recommendations given for the third cave in the study area.

Of the three caves adjacent to the area, one receives limited human use and no restrictive recommendations have been made for it at the present use level. One of the caves is on private land and is not frequently visited. The owner has been contacted but is not interested in selling or otherwise conveying the land. The other cave is in the Irish Wilderness and is frequently visited by people floating the Eleven Point River. Indiana bats have used this last cave in the past, but present use is unknown. No recommendations have been made regarding use restrictions for this cave.

Gray bat populations will be protected from habitat destruction and human disturbance to the greatest extent possible in the No Action alternative.

Indiana bat

In addition to the protective measures already stated for gray bats, the Forest Plan policy of leaving snags and den trees throughout the study area may assure maternity roosting sites for Indiana bats.

Indiana bat populations will not be adversely affected by carrying out the No Action alternative.

Eastern cougar

As roads are closed, there should be less opportunity for human-animal conflict. An increase in permanent openings and a continued program of timber harvest will provide increased habitat for deer and small mammals. Under the No Action alternative, the study area will continue to provide marginally suitable habitat should a reintroduction program be proposed by the Department of Conservation or US Fish and Wildlife Service.

Ozark cavefish

Cave mapping or surveys by qualified individuals could result in the finding of new populations of Ozark cavefish in the study area. Indiscriminate cave exploration could disturb or destroy unknown populations of cavefish.

Blue sucker

Because activities carried out in the study area will use best management practices to reduce the possibility of degradation of water entering the groundwater system, it is highly unlikely that blue sucker populations in the Current River will be affected in any way by the No Action alternative.

Carex decomposita, Heartleaf plantain, False hellebore, and Prairie white-fringed orchid

The known locations of these plants will be protected by not allowing management activities to take place within a designated buffer zone. The extent of the buffer zone will depend on the site specific location and extent of the population. There is a low likelihood that surveys may result in the discovery of new populations of these species. However, there is also a slight possibility that unknown populations could be disturbed by management activities. Current populations of heartleaf plantain should be monitored to detect any changes.

Potential habitat for heartleaf plantain on the study area is protected by standards and guides relating to streambeds and wetlands (See Mark Twain National Forest Land and Resource Management Plan pages IV-45 through IV-58 sections 2500,2600). Wetlands which could provide habitat for prairie white-fringed orchids will be identified during inventory and project field work.

It is extremely unlikely that the No Action alternative will cause any adverse effect of any of these plant species.

ALTERNATIVE B - PROPOSED ACTION

EFFECTS OF EXPLORATION

Bald Eagle

The potential for birds to be killed or disturbed by exploration activities is very low; however, the loss of one bird represents a loss of 5-11% of birds surveyed annually. A very slight possibility exists that individual eagles could be struck by a vehicle while feeding on carrion at the side of a road or shot by drill rig workers while roosting along the roadside. The presence of human activity and noise within the river zone could cause feeding or resting birds to move out of the drilling area until the disturbance ceased. Continual disturbance during December through March could affect the wintering population of the study area by causing one or more birds to move permanently out of the study area and find areas of less disturbance. The birds, however, may habituate to the activity over a period of time.

Eagles wintering on the Current River will not be affected by exploration activities on the study area.

Gray and Indiana bats

Noise and vibrations from drilling activities could cause disturbance to maternity colonies or hibernating bats if located near an occupied cave. However, with restrictions on drilling over known caves and in the river zone, it is very unlikely that this disturbance would occur. If it did occur, gray or Indiana bat populations may be adversely impacted. Drill holes may intersect unknown caves which could disturb bat populations. Although intersecting an unknown cavern is possible, it is unlikely that gray or Indiana bat populations would be present.

Eastern cougar

Only a small acreage is affected by exploration

activities and so there should be little effect on potential habitat. A slight increase in numbers of temporary roads along with increased drilling activity will create disturbances which would be avoided by any animals in the study area. This activity will undoubtedly take place, but the likelihood of these animals being present is very low.

Ozark cavefish

Because of the prohibition against drilling over known caves, there should be no effect on potential habitat from exploration activities. Drilling is likely to intersect unknown caves, but the chances of cavefish inhabiting these caves are remote.

Blue sucker

Exploration activities will not affect water entering the Current River and thus there will be no effect on blue suckers from exploration activities.

Carex decomposita, Heartleaf plantain, False hellebore, Prairie white-fringed orchid.

There should be no effect on these plant populations from exploration activities. Known locations will be protected from activities and potential habitat will be field checked prior to approval of hole locations.

EFFECTS OF LOW LEVEL DEVELOPMENT

Because of past problems in the Old Lead Belt and in the Viburnum Trend, one of the major concerns with mine development is tailings disposal and potential effects on water quality which could affect listed species. Missouri Department of Natural Resource regulations prohibit the discharge of mine or mill effluent into the scenic rivers or waters draining thereto. In the study area, tailings disposal would have to be done in a closed system so there was no leakage to the rivers. By complying with this regulation, the only way waters of the study area would be affected would be accidental or unintentional. It is very difficult to predict what the probabilities of an accidental or unintentional discharge of effluent would be. There is also some doubt as to whether a closed waste disposal system can be built or maintained in the study area.

Bald Eagle

Effects of exploration under the low development scenario will be similar to the effects of the exploration only scenario.

Depending on the site chosen for a mine/mill, wintering bald eagles may be disturbed by noise and activity associated with construction and operation of a mine/mill. Bald eagles will tend to avoid areas of human presence and will desert feeding areas during the time humans are present. Increased traffic along highway 19 will increase the chances of human/eagle contact and the possibility of human induced mortality and disturbance, i.e. individual eagles may be shot while roosting along the road or struck by vehicles while feeding on road-killed carrion.

The construction of a 100' wide powerline would present a problem and an opportunity. Individual eagles could be electrocuted by coming in contact with lines during migration and hunting (depending on the location of the line). Constructing lines using guidelines developed in Olendorff et. al., 1981, will help avoid this problem. Artificial nesting platforms have been constructed on powerline supports in at least one area of the country. Again depending on the location of the line, nest platforms could be constructed to encourage eagles to stay in the area year-round.

There is a possibility that mine/mill effluents could be released into waters draining into the Eleven Point River. Lead, zinc, copper, milling reagents, blasting compounds, oil, diesel, and other substances can be found in varying amounts in mill water, mine water, and tailings. Wind blown particles from the tailings dam and pond are deposited on soil and can enter streams during runoff. It is very likely that this will happen to some degree, but, depending on the distance from the river, the substances would probably be diluted so much as to be undetectable.

A large flood could wash tails directly into streams. This is a possibility in the study area and could result in a large slug of material being released into area waters. This could be a temporary effect if the material was washed on through the river during the flood, although it will eventually be deposited somewhere.

Failure of the tailings pond dam would cause a massive release into the watershed. There are conflicting opinions on how high or low a probability this is. Leakage from the bottom of a pond would release substances into the ground water system. There are also conflicting opinions on what the probability of this occurring is.

Uncovered vehicles hauling concentrate may blow heavy metal particle on soil to enter streams as runoff. This would definitely occur if vehicles are not covered, and the biggest problem would be close to the roads. If vehicles are covered, there would be no possibility of this happening except in an accident.

When these substances enter the aquatic system they can be absorbed into an organism's system or adsorbed onto the surface tissues of both plants and animals.

Eagles are fish-eating birds, tending to take those fish feeding near the surface, or fish in the shallows. If these fish are contaminated with heavy metals or other substances, the contaminants will be passed along to the eagle. Although top-feeding fish are less likely to have high metals concentrations than

bottom feeders (Schmitt and Finger, 1982), most stream fish are bottom feeders which may be found in shallow water.

Eagles will also eat carrion which may be contaminated. Eagles do not regurgitate castings and thus retain lead in their system (Stendall, 1980 in Kania and Nash, 1987). Lead may interfere with fertility or normal sexual development and a threshold point is eventually reached where the bird quits eating and starves (Pattee et al, 1981 in Kania and Nash, 1987). Levels of >10 ppm in the liver or >5 ppm in the kidney are good indicators of acute exposure to lead in eagles (Pattee et al, 1981 in Kania and Nash, 1987).

Gray bat and Indiana bat

Exploration effects would be the same for the low development scenario as for the exploration only scenario.

The two ways in which a mine/mill operation could affect endangered bats are through disturbance and change in water quality or quantity. Past human disturbance is one of the primary causes of decline of these bat populations. Additional disturbance from recreational caving, noise and vibration from drilling, construction, and blasting might have an adverse effect on bat populations in the study area.

The caves within the study area known to harbor bats are all within the Eleven Point National Scenic River zone. It is unlikely that a mine would be constructed close enough to one or more of these caves to cause a problem. However, shafts blasted to recover ore may come close, and drill holes may also be located close. If the bats are disturbed during the winter, they will awaken from hibernation and use stored fat. Each arousal uses about 10-30 days supply of fat needed to last through hibernation (Daan, 1973 in U.S. Fish and Wildlife Service, 1982). Too many arousals will use up enough fat so the bats will be forced to awaken early in the spring (Mohr, 1975). If this happens before the insects are out, the bats may starve (Mohr, 1975). Even the footfalls of visiting cavers and the light and heat from their lanterns can disturb hibernating bats (Mohr, 1975). Indiana bats are so intolerant of disturbance that an entire hibernating colony disappeared after researchers banded some individuals for study (Mohr, 1975).

New-born bats cling to their mothers very early in life. The females roost with and suckle their young for 20-35 days until the young are able to fly and forage on their own (Evans, 1985/U.S. Fish and Wildlife Service, 1982 and 1983). If a maternity colony is disturbed in spring or early summer, the young bats may fall from their mother and die.

Although both Indiana and Gray bats are extremely loyal to their traditional caves (Mohr, 1975), one possible consequence of disturbance is that the bats may desert the cave and search for another suitable cave. Each bat species has a narrow range of temperature and humidity that is optimum (Mohr, 1975). Caves with the proper combination are limited in number. When forced into a different cave or another area of an occupied cave, the bats may be forced to use more energy than they would in an optimum habitat. Energy used in compensating for less than optimum habitat is not available for feeding, breeding, growth, hibernation, and caring for young. As a result, individuals might suffer lower body weights, reproductive failure, or death. Colonies which relocate usually die out in time (Clawson, personal communication).

One way to lessen disturbance from recreational caving is to gate the entrance to the cave. One cave in the study area already is gated, but two are not. Gates must be designed so the bats can pass through them easily and so the gate does not interfere with or change the passage of air and water through the entrance. One of the bat caves in the study area does not lend itself easily to gating.

Education of the general public and the mine/mill workers also may lessen the chances for deliberate or unintentional disturbance. Recommendations for management of the bat caves in the study area can be found in "An Inventory and Evaluation of Cave Resources of Mark Twain National Forest, Gardner and Gardner 1982.

Prohibiting drill holes, vent shafts, mine sites and other facilities within the zone of influence of known bat caves would almost eliminate the potential for this type of disturbance. The zone of influence would have to be determined individually for each bat cave.

Because these bats feed primarily on aquatic insects, a change in water quality would affect the food source and possibly the bat population. Gray bats are opportunistic feeders with almost all prey being associated with water (Missouri Fish and Wildlife Information System). The larger prey tends to be soft-bodied with poor flying ability (Missouri Fish and Wildlife Information System). Indiana bats appear to favor moths, but eat a variety of other aquatic insects (Missouri Fish and Wildlife Information System).

Mayflies, stoneflies, and caddisflies are the major food sources for gray bats (U.S. Fish and Wildlife Service, 1982) and are the most abundant component of the benthic macroinvertebrate community in unpolluted Ozark streams (Ryck, 1973). Different species have different habitat preferences, but all need high dissolved oxygen levels, low turbidity and sedimentation, many species and a large number of periphyton as a food source, and an abundance of substrate niches (Ryck, 1973). Compared to other benthic macroinvertebrates, these insects are very intolerant of aquatic pollution (Fremling, 1968 in U.S. Fish and Wildlife Service, 1982 and Ryck, 1973). Diversity indices can be used to determine relative water quality of a stream. Ryck, 1973 found that unpolluted streams have a diversity

index of > 4.0 with a minimum of 8 taxa of mayflies and stoneflies; moderately polluted waters have a diversity index of 3.0-3.9 with 4-7 taxa; heavily polluted streams have diversity indices of 2.2-2.9 with < 4 taxa; and grossly polluted waters have a diversity index of < 2.2 with no mayflies or stoneflies present. In polluted waters there are typically large numbers of organisms but very few taxa (Ryck, 1973).

In some rivers and streams of the Viburnum Trend, the numbers of species and individuals of mayflies and stoneflies were drastically reduced as a result of organic pollution caused by milling effluents and the elimination of habitat caused by tailings washing into the water and filling up pools and riffles (Ryck, 1973). After improving the tailings pond system to recycle mill waters, there was a noticeable increase in diversity and numbers of species in one stream (Ryck, 1973). Recovery of a population can be rapid after a release of pollutants if there is a source of organisms for recolonization in an unpolluted section of water upstream (Ryck, 1973).

If the waters of the study area were contaminated with heavy metals and milling reagents, these insects would also be reduced in the study area. It is not likely that gray bats would be able to meet their food needs from other species, change food sources if these insects were reduced, or receive the same nutritive value from substitute food sources. Animals usually adapt their feeding behaviors to take prey which gives the greatest net gain for the energy expended to catch it. Alternate food sources may take more effort to capture, using energy which would otherwise be available for growth, breeding and hibernation.

If they could not feed primarily on other insects, the bats would be forced to move to other areas where suitable caves and foraging areas are probably already occupied. The impact on the bat colonies could range from very little if other insects of high food value were present and available, to total decimation of a particular colony or colonies along the river. It is unlikely that a large enough slug of contaminants would be deposited in a relatively short time in the entire length of the river to cause the latter case. It is much more likely that a long term low volume deposit might occur.

If mine water pumping should lower the water table of the study area, the water levels in the bat caves of the study area could be permanently lowered. This could change the humidity of the cave or of certain areas in the cave and make them unsuitable for the bats. So far as is known, the water tables of both the Old Lead Belt and Viburnum Trend have not been affected by mine water pumping.

Eastern cougar

Exploration effects would be the same for the low development scenario as for the exploration only scenario.

Potential habitat for this species would be affected by a mine/mill operation in the study area. Cougars do not tolerate human presence or activity very well and move to areas of less disturbance or shift activity times to avoid humans (Missouri Fish and Wildlife Information System and Van Dyke et al. 1986). The increase in road density and traffic associated with a mine/mill would make the study area less suitable as potential habitat.

If any cougars were present in the study area, they also could be affected by the release of heavy metals and other contaminants into the environment. Deer in counties of the Viburnum Trend have been found to have elevated levels of lead in their bones (Wixson, 1977). Because deer are a primary prey of cougars, any metals concentrated in deer would be passed along. Other herbivores which cougars eat, such as rabbits, may also pass along contaminants they pick up from vegetation. Drinking water would also be a potential source of contaminants. What effect this would have on individuals and what concentrations would be harmful is unknown.

Potential effects may be similar to those seen in laboratory experiments and from observations using rats and cats. These animals have been known to suffer reduced growth rates from cadmium and zinc; and sheep, dogs, and cattle have suffered loss of appetite and jaundice from copper (McKee and Wolf, 1963). Lead, zinc, cadmium and copper are all fatal to some mammals at different concentrations (McKee and Wolf, 1963). Recommendations for safe levels in drinking water for animals are: lead <= 0.5 mg/l and cadmium <= 0.1 mg/l (McKee and Wolf, 1963).

The likelihood of any animals being permanent residents of the study area is very low. If there are individuals in the area, it is unlikely that the effects discussed above would occur in such magnitude that the animals would be affected.

Ozark cavefish

Exploration effects would be the same for the low development scenario as for the development only scenario.

There are no known Ozark cavefish populations in the study area, so any effect would be on undiscovered populations or potential habitats. Because most known Ozark cavefish caves depend on bat guano for their food source, any disturbance to the bats which causes them to desert a cave will also have adverse impacts on the cavefish population (U.S. Fish and Wildlife Service, 1983). Another energy source must be found or the cavefish population will decline. Gray bats are the primary colonial bat in Ozark cavefish caves (Willis, 1986). There is an unknown likelihood that undiscovered bats or cavefish will be disturbed, but any decline in the population would be serious.

Disturbance to cavefish from recreational

caving or vibrations from drilling and blasting can interrupt breeding and increase the need for food in a food-scarce environment (Willis, 1986). This would cause lower reproductive success, possible direct mortality from starvation, and a decrease in the population. It is not expected that there will be a large increase in people exploring caves as a recreational activity, even with an influx of mine/mill workers. Although there is a slight possibility that drilling or mine shaft construction could intersect unknown caves with populations of Ozark cavefish, the major threat to potential habitat or to undiscovered populations is a change in water quantity or quality due to mine/mill operations.

Most Ozark cavefish caves have relatively low dissolved oxygen concentrations (Willis, 1986), and anything which increases the biological oxygen demand (BOD) will use oxygen which is needed for maintenance of aquatic fauna, including cavefish. Organic and inorganic nutrients present in mine waters or mill effluent would increase BOD.

To what extent heavy metals concentrations and milling reagents would cause impacts on undiscovered cavefish is unknown. Heavy metals in water can be absorbed and can adsorb onto surface tissues of aquatic organisms. Benthic organisms and plankton, both of which are food for Ozark cavefish, may be reduced by heavy metal concentrations (Czarnezki, 1985). Lead and zinc react with mucous and form a film over the gills and body of fish which can lead to suffocation (McKee and Wolf, 1963). Copper and cadmium are both toxic to fish at varying concentrations (McKee and Wolf, 1963). A coating of oil on the surface of cave waters could interfere with respiration. If oil coats the bottom, spawning beds and benthic food organisms could be destroyed (McKee and Wolf, 1963). All these effects would reduce the population of an individual cave or caves if any exist in the study area.

A decrease in the water table could conceivably lower water levels in caves, which would decrease available habitat for cavefish. The likelihood of permanent water table changes from mine water pumping is low under the low development scenario. The Ozark Cavefish Recovery Plan lists protection of aquifers and recharge zones as a crucial step in protecting and recovering Ozark cavefish populations.

Blue sucker

Research in the Old Lead Belt and the Viburnum Trend has confirmed that bottom feeding fish such as suckers tend to accumulate high levels of heavy metals (Schmitt and Finger, 1982). Feeding in contaminated bottom sediments, these fish accumulate heavy metals on body surfaces and ingest contaminated sediment and detritus (Czarnezki, 1985).

Mine water and mill effluents would have to enter the groundwater system and flow to the Current River for there to be any effect on blue suckers. It is approximately eleven miles from the eastern edge of the study area to the Current River. Dilution would play a large role in determining the severity of effects due to water contamination. A tailings pond collapse is probably the only way large quantities of heavy metals and other contaminants could travel through the groundwater and reappear in the Current River. Although a tailings pond collapse is considered by many to be a good possibility in the study area, it is not known how much material, if any, would end up in the Current River. It may be that not enough material would reach the Current River to cause any detectable effect on blue suckers, or it may be that a situation like that in the Old Lead Belt could occur where health advisories have been issued against eating suckers from the Big River because of elevated lead levels.

Slow leakage from the bottom of a tailings pond could result in varying quantities of metals and reagents entering the ground water system. How much material might actually reach the Current River is unknown. The potential for slow leakage is much greater than the potential for a tailings pond collapse.

Carex decomposita and false hellebore

Effects of exploration under the low level development scenario will be the same as in the exploration only scenario.

Carex decomposita is found in one location in the study area and false hellebore is found in 3 locations in the study area. These locations will be protected from activities associated with mine/mill construction and operation.

The potential effects of a release of heavy metals and milling reagents on these species are not known. However, lead, zinc, cadmium, and copper have all been shown in laboratory experiments to be toxic to some crop plants at varying concentrations (McKee and Wolf, 1963). Zinc, copper, and lead have all caused delayed germination and slower growth rates in cress and mustard seeds (McKee and Wolf, 1963). Copper has been known to stop root growth and decrease the length of the main stem of tomato roots (McKee and Wolf, 1963). If Carex decomposita and false hellebore react the same way as these plants to heavy metals concentrations, there could be adverse impacts. Shorter roots would reduce the ability to absorb water and nutrients, thereby reducing the probability that individual plants would survive. Delayed germination and slower growth might adversely affect the plant's ability to reproduce at the right times. High concentrations of heavy metals could kill plants outright. Any of these changes would cause a decline in the population of Carex decomposita and false hellebore in the study area. The probability of an accidental or unintentional release of heavy metals and milling reagents occurring is unknown, as is the probability of any release reaching plant locations.

Heartleaf plantain, prairie white-fringed orchid, and Carex decomposita

Effects of exploration under the low level development scenario will be the same as in the exploration only scenario.

These species are found in or near water located in the Ozark National Scenic Riverways. The only way in which mine/mill operations in the study area could affect these plants is if there were a change in water quantity or quality as a result. It is known that plants can adsorb heavy metals onto surface tissues and can also absorb these substances through roots, stems, or leaves. Experimental evidence has shown that some concentrations of metals can be harmful to some plant species (see discussion above). It is extremely unlikely that concentrations high enough to cause adverse impacts to these plant species would ever reach the Current River.

EFFECTS OF HIGH LEVEL DEVELOPMENT

The effects of a high development level would be similar to those of the low development scenario. The chances that the effects will occur are greatly increased with high development but the intensity of an effect depends on many factors and may be at least proportionately greater, the same, or only slightly greater than for low development. It will be more difficult to avoid endangered species habitats during drilling and construction of facilities; there will be many more people living in the area, traveling to and from work, and using the resources of the area for recreation; more access roads and utility corridors will be needed; and more waste products will be generated and disposed of.

There is a higher probability that a mine or mines will be located close to the river where eagles and bats are. Each facility would generate noise and activity that is potentially disturbing to these three species.

The activities associated with eight mines in the study area would definitely preclude the possibility of finding suitable cougar habitat.

Compared to the low development scenario, there is a higher possibility of drilling or shaft construction intersecting caves with potential Ozark cavefish habitat or undiscovered populations.

Eight mines will produce much more waste products than one mine and the chance of accidental release of mine/mill effluents increases with each facility. The effects of a release would depend on where it occurred, what and how much was released, and other factors as discussed for each species in the low development scenario.

ALTERNATIVE C - CURRENT DIRECTION

Because maximum modification under the visual management system is not allowed in Visual Variety Class A, there will be no large powerlines or tailings disposal sites permitted in approximately 80% of the study area. The following evaluations assume that if no powerlines or tailings ponds are permitted, there will be no mine/mill structures located in Visual Variety Class A. Drill holes, vent shafts, and low standard access roads may be constructed in Visual Variety Class A.

EFFECTS OF EXPLORATION

The effects of exploration will be the same as the Proposed Action for all
species no matter which alternative is chosen.

EFFECTS OF LOW DEVELOPMENT

Bald Eagle

Because there will be no powerlines permitted in Visual Variety Class A, there are only three areas where mining facilities could come near the Eleven Point River. Figure B shows those three areas, and the extent of Visual Variety Class A. Two of the three areas are mostly private land. If a mine were located in one of these three areas, it is possible that a small portion of the river could be close enough for noise to disturb any eagles on that portion. Any individuals disturbed would probably move to a different part of the river where there may or may not be other eagles to compete with for food.

Drill holes may be located near the river and could cause temporary disturbance.

Water quality concerns are the same as Alternative B - Proposed Action.

Because of the karst topography, it is possible that an accidental release of mine/mill effluents could reach the Eleven Point River from almost anywhere in the study area. Dye traces have located recharge points for some parts of the study area.

Gray and Indiana bats

All known gray and Indiana bat caves are located within Visual Variety Class A. One cave is withjn 1/2 mile of the variety class boundary so it is possible that mine facilities could be located near the cave. This location is on private land. If a mine was located here, noise could disturb the bats, depending on atmospheric conditions. If disturbed, the effects would be the same as in Alternative B - Proposed Action.

It is more likely that a mine and associated facilities would be located in the north or east parts of the study area which are far from any bat caves.

Dye tracings have shown that ground water in the study area move relatively fast and in no relation to surface watersheds; therefore, even if located far from the caves, accidental or unintentional releases of mine/mill wastes could reach the waters draining into bat caves

or the Eleven Point River. Effects from a change in water quality would be the same as for Alternative B - Proposed Action.

If located in the north or east part of the study area, a mine would be far enough from the caves to have little or no effect on ground water levels from mine pumping.

Eastern cougar

Potential habitat would only be affected in Visual Variety Class B. This part of the study area has more private land interspersed with National Forest System Lands, is more developed, and is currently much less suitable as potential habitat than the rest of the study area. Therefore, low development will not have any effect on the suitability of habitat in 80% of the study area, and should not significantly affect suitability of the remaining 20%.

Ozark cavefish

All known caves in the study area fall within Visual Variety Class A. Disturbance to caves would therefore be limited to drill holes, possibly vent shafts, and recreational use. It is highly unlikely that these activities will affect potential cavefish habitat or unknown populations in the low development scenario.

Water quality concerns are the same as in Alternative B - Proposed Action.

Pumping of mine water in the north or east part of the study area would be unlikely to affect water levels in potential cavefish habitat.

Blue sucker

The effects of water quality changes would be the same as in Alternative B - Proposed Action. Dye tracing has shown that ground water in parts of the north and east part of the study area emerges at Big Spring on the Current River (U.S. Forest Service). How much material from an accidental release of mine wastes might reach the Current River is unknown.

Carex decomposita and false hellebore

All known populations are located within Visual Variety Class A. These locations will be protected from surface disturbing activities associated with mine activities.

Water quality concerns are the same as for Alternative B - Proposed Action, but it is much less likely that an accidental release of wastes would reach locations of these plants.

Heartleaf plantain, prairie white-fringed orchid, and Carex decomposita

Potential effects on these plants of the Ozark National Scenic Riverways are the same as for Alternative B - Proposed Action. The possibility of accidental releases of mine wastes reaching the Current River is unknown but probably very slight under low development.

EFFECTS OF HIGH DEVELOPMENT

Under this scenario, most development will occur in the north and east parts of the study area. About 40% of National Forest system lands in Visual Variety Class B and C will be in some type of mine-related development. Although this part of the study area has more private land and is already more developed than the remaining area, this level of development will be highly noticeable.

Bald Eagle

Effects will be the same as for the low development scenario, but there is a higher possibility that a mine would be located in one of the three areas close to the river.

Gray and Indiana bats

All effects will be the same as for the low development scenario, except that there will be a higher possibility of mine water pumping affecting the water level of the entire study area with eight mines.

Eastern cougar

The part of the area in Visual Variety Class A will be unaffected as potential cougar habitat except at the edges. Visual Variety Class B will be unsuitable for potential cougar habitat because of the numerous mine-related developments which would occur there.

Ozark cavefish, blue sucker, Carex decomposita, false hellebore, heartleaf plantain, and prairie white-fringed orchid

Effects will be the same as the low development scenario except that as the number of mines increases, the potential for accidental release of wastes also increases.

ALTERNATIVE D - CHANGE VISUAL QUALITY STANDARDS

This alternative changes visual quality standards to allow powerlines and tailings ponds in Visual Variety Class A with some restrictions. Powerlines, waste disposal sites, haul roads and mill sites will not be allowed in the foreground of sensitivity level one travelways or use areas; and powerlines and waste disposal sites will not be permitted in sensitivity level one middleground. Mine structures will still be possible in most of the study area.

It will be more difficult to locate mines near the Eleven Point River because the Ozark Trail, Highway 19, Forest roads 3152, 3155, 3190, and 3153 are all sensitivity level one travelways near the river. These additional restrictions will provide further protection from disturbance for bald eagles and gray and Indiana bats whose habitat is located along the river.

All other effects on federally listed species will be very similar to Alternative B - Proposed Action.

ALTERNATIVE E - MODIFY MANAGEMENT PRESCRIPTION AREAS

Although changing management prescription 6.2 to 3.4 in the study area will allow greater road densities, most of the area lies within Visual Variety Class A. No large powerlines or tailings ponds will be permitted in the majority of the 6.2 area even if the management prescription is changed. Therefore, all effects of this alternative on federally listed species will be identical to Alternative C - Current Direction with one exception. If higher road densities were needed for access to drill holes, that part of the area would be less suitable for potential cougar habitat. Most access roads would be low standard and closed as soon as not needed, so the effect would be very little.

ALTERNATIVE F - MODIFY VISUAL AND MANAGEMENT PRESCRIPTION

The effects on all federally listed species of changing the visual standards to allow facilities in most of the study area and changing a management prescription to allow development and higher road densities in the 6.2 area will be the same as in Alternative D with the exception noted in Alternative E for potential cougar habitat.

MITIGATING MEASURES

The following measures can be implemented in any alternative to either lessen an impact or reduce the potential for an impact to occur.

1. Mark Twain National Forest Land and Resource Management Plan standards and guidelines provide direction to prevent management decisions and activities from disturbing or destroying caves, special habitats, and Federal or state listed species (pages IV-18 and 19, IV-49-58). These standards and guidelines will be followed no matter what alternative is chosen.

2. Design and construction of powerlines will follow recommendations in Olendorff et al. 1981, to reduce the chances of eagle and other raptor electrocution. Artificial nesting platforms may be constructed on utility supports, if appropriate, to encourage raptor nesting.

3. Recommendations in the recovery plans for gray and Indiana bats and An Inventory and Evaluation of Cave Resources of Mark Twain National Forest, Gardner and Gardner, 1982, will be followed for known bat caves. All other caves in the study area will be managed according to recommendations in Gardner and Gardner, 1982. This may include gating, signing, or otherwise closing caves to visitors. Successful closures will greatly reduce the chance of disturbance from casual cavers to the cave community, including gray or Indiana bats and potential Ozark cavefish habitat.

4. Closing and revegetating roads as soon as they are no longer needed will reduce access, thereby maintaining the suitability of potential habitat, and reducing the potential for conflict between people and cougars.

5. No surface occupancy restrictions will be imposed where listed plants are known to be located. No activities will be permitted to occur on sites where either plant or animal species are found. Buffer zones may be established around these areas within which no activities will be permitted. This measure will insure that populations are not destroyed by locating facilities on known habitat.

6. Field surveys of proposed facility sites should be conducted by a wildlife biologist or a botanist prior to work being initiated. The person conducting the survey should be knowledgeable on characteristics of both plant and animal species. Unknown populations or individuals may be located and protected from disturbance if this is done.

7. Environmental education efforts may reduce the potential for unintentional harassment or destruction of listed species and their habitat. This effort should stress the ecology or the area, unique habitats and species, and awareness of potentially damaging activities. It is difficult to determine how effective this measure may be.

CUMULATIVE IMPACTS

Cumulative impacts are the incremental impacts of an alternative when added to past, present, and reasonably forseeable future activities in the area. Other activities which could increase the negative effects of mining include developed and dispersed recreation, hunting, fishing, and trapping, timber sales, road construction and activities along roads and trails. Impacts from these activities would combine with mining to increase the pressures on listed species in the study area. In this evaluation, potential habitat for cougars and existing populations of Indiana and gray bats would be most affected by cumulative impacts.

There will be minimal cumulative effects from the exploration scenario of any of the alternatives. Some additional access roads will be constructed, but these will be closed and rehabilitated when they are no longer needed. There will be a short-term loss of suitability of potential cougar habitat when the roads are being used.

The low development scenario of any alternative will create an additional 500 acres of cleared land. This is less than one percent of the study area so there will be essentially no cumulative effects from land clearing. All acres, except perhaps a tailings disposal site, could be returned to their existing condition when operations are completed.

Mine-related activities combined with normal forest management will affect much of the study area. Noise and human activity will be in-

creased slightly by mining activity. As long as facilities are not located adjacent to caves or the Eleven Point River, noise and activity would only affect potential cougar habitat; and then only for the time the facilities were used.

High development in each alternative will create an additional 4000-5000 acres of cleared land and will mean more roads and activity occurring in the study area. The only difference in alternatives is where the clearing would take place. In Alternatives 3 and 5 it would be concentrated in the north and east part of the study area; while in Alternatives 2 and 6 it could take place throughout the entire area; and in Alternative D it could take place anywhere except the 6.2 area. Drilling may take place in the Eleven Point River Zone, but development is incompatible with scenic river objectives.

The only cumulative effects on the bald eagle would be from disturbance created by noise and activity associated with mining operations, logging operations, or winter river recreation.

Because gray and Indiana bat caves are located primarily along the river, an increase in the number of people using the river for recreation will also increase the chances for more visitation and disturbance of bat caves. In addition to an expected increase in river recreationists from outside the area, many mine/mill workers and their families will probably use the river for fishing, swimming, floating, and other recreational activities, including perhaps cave exploration. Added to the existing river recreation, there could be a threat to the populations along the river.

Potential habitat for cougars would be affected by the noise and human presence of all forest management and mining activities. Any area where operations were taking place would be unsuitable for the duration of the activity. Timber sales will affect approximately 890-1715 acres per year in the study area. The activities associated with logging would be avoided by any cougars still existing in the area. Roads into cutting units combined with access roads needed for drill sites, vent shafts, and other facilities, will increase traffic into the areas which is detrimental to cougar habitat and increase the opportunity for cougar/human conflict. Timber sales will increase the area in brushy habitat favored by the cougar's favorite prey, deer; and new powerlines will increase the area in herbaceous vegetation favored by rabbits and other small mammals - also cougar prey.

The only cumulative effect on Ozark cavefish would be an increase in recreational caving due to influx of mine workers. More disturbance than currently exists could decrease the suitability of potential habitat.

There will be no cumulative effects on blue suckers in the Current River.

As activity of any kind increases, there is more potential for new populations of the two listed plant species in the study area to be discovered and more potential for known populations to be disturbed. There will be no cumulative effects on the three listed plants in the Ozark National Scenic Riverways.

BIOLOGICAL EVALUATION

It is the evaluation of the U.S. Forest Service that Alternative A - No Action "will not affect" any Federally listed plant or animal species.

It is also the evaluation of the U.S. Forest Service that an exploration only scenario under any alternative "will not affect" any Federally listed plant or animal species. This course of action depends on whether or not ore deposits are discovered which are economically efficient to produce. If a lease is issued, the company must determine whether or not to proceed farther than the exploration stage. Forest Service and Bureau personnel set conditions and stipulations on production operations, but do not control the decision on whether or not to continue after exploration is completed.

For all alternatives, development of any discovered mineral deposit "may affect" potential habitat for eastern cougar, wintering populations and potential nesting habitat of bald eagle, and existing populations of gray and Indiana bats. Alternatives C and E reduce the potential for impacts to occur on these species by restricting activities which can take place in much of the study area. Alternatives D and F also reduce the potential for impacts to bald eagles and both bat species by restricting activities which can occur near the river, although Alternative F does allow development to take place in the 6.2 area. Alternative B has the highest potential to affect all species by allowing all types of mineral development activities throughout the study area.

Mitigation measures proposed in this assessment and the EIS and special stipulations attached to a lease will lessen the potential for impacts to occur from any alternative, but cannot eliminate them.

The "may affect" evaluation is based primarily on an increase in human activity which is detrimental to eastern cougars; and the lack of information on how a potential accidental or unintentional release of heavy metals and milling reagents into area surface or ground waters might affect eagles or bats.

It is the recommendation of this assessment that formal consultation be initiated with the U.S. Fish and Wildlife Service.

INFORMAL CONSULTATION

This biological assessment was reviewed informally by the following individuals. Their comments and suggestions are appreciated and were incorporated into this assessment.

Clawson, Rick - Wildlife Research Biologist, Missouri Department of Conservation, Columbia, MO

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Houf, Larry - Wildlife District Supervisor, Missouri Department of Conservation, West Plains, MO

Parker, Dr. Mamie - Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, Columbia Field Office, Columbia, MO

Putman, Charley - Wildlife Biologist, Mark Twain National Forest, Van Buren, MO

Wilson, Jim D. - Ornithologist, Missouri Department of Conservation, Jefferson City, MO

Wilson, Jim H. - Endangered Species Coordinator, Missouri Department of Conservation, Jefferson City, MO

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CONSULTATION WITH OTHERS

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APPENDIX 10

OCCURENCE OF LISTED SPECIES AND SPECIES OF CONCERN - ANIMALS

STUDY AREA

Species	Scientific Name	Status[1]	Location[2]	Source[3]
A crayfish	Orconectes eupunctus	U	Eleven Point River	1,2
A crayfish	Orconectes marchandi	U	Eleven Point River	2
A micro caddisfly	Ochrotrichia contorta	U	Greer Spring	2
A mussel	Villosa lienosa lienosa	MO-R	Eleven Point River	1,4
A net-spinning caddisfly	Symphitosyche piatrix	U	Greer Spring	4
A primitive caddisfly	Agapetus artesus	U	Greer Spring	2
Bald eagle	Haliaeetus leucocephalus	FE, MO-E	Eleven Point River	5,7
Black-crowned night heron	Nycticorax nycticorax	MO-R	Eleven Point River	5,7
Checkered madtom	Noturus flavater	MO-W	Eleven Point River	6
Cooper's hawk	Accipiter cooperii	MO-E		2,5,7
Gray bat	Myotis grisescens	FE, MO-E	Eleven Point River	2,3,4
Great blue heron	Ardea herodias		Eleven Point River, Irish Wilderness	3,4,7
Indiana bat	Myotis sodalis	FE, MO-E	Irish Wilderness	4
Least brook lamprey	Lampetra aepyptera	MO-W	Eleven Point River	6
Mooneye	Hiodon tergisus	MO-W	Eleven Point River	6
Red-shouldered hawk	Buteo lineatus	MO-R		4,7
Ruffed grouse	Bonasa umbellus	MO-R		5,7
Salem cave crayfish	Cambarus hubrichti	U	Greer Spring, Eleven Point River	3,4
Sharp-shinned hawk	Accipiter striatus	MO-E		2,5,7
Southern cavefish	Typhlichthys subterraneus	MO-W	Eleven Point River, Turner's Mill	2,3,4
Swainson's warbler	Limnothlypis swainsonii	MO-E	Eleven Point River	2,5

[1] FE, Federal Endangered; MO-E, Missouri Endangered; MO-R, Missouri Rare; MO-W, Missouri Watchlist; U, Status Undetermined in Missouri
U/R = UNDETERMINED STATUS/RELIC POPULATION

[2] Specific locations for species are contained in the files of the Winona Ranger District, Mark Twain National Forest.

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OTHER LISTED SPECIES AND SPECIES OF CONCERN POSSIBLY OCCURRING IN STUDY AREA[1]

Species	Scientific Name	Status[2]	Source[3]
A riffle beetle	Ancyronyx variegata	U	1
American bittern	Botaurus lentiginosus	MO-R	3
Barn owl	Tyto alba	MO-E	1
Black bear	Ursus americanus	MO-R	1,3
Eastern cougar	Felis concolor	FE, PEX	2
Keen's myotis	Myotis keenii	MO-R	3
Little blue heron	Egretta caerulea	MO-R	1,3
Long-tailed weasel	Mustela frenata	MO-R	1,3
Northern harrier	Circus cyaneus	MO-E	1,3
Osprey	Pandion haliaetus	MO-E, (migrant)	1,3
Ozark cavefish	Amblyopsis rosae	FT	5
Rafinesque's big-eared bat	Plecotus rafinesquii	MO-R	3
River otter	Lutra canadensis	MO-R	1
Snowy egret	Egretta thula	MO-E	3
Swamp rabbit	Sylvilagus aquaticus	MO-R	1
Wood frog	Rana sylvatica	MO-R	1,3

OZARK NATIONAL SCENIC RIVERWAYS AND LOWER CURRENT RIVER[1]

Species	Scientific Name	Status[2]	Source[3]
A caddisfly	Symphitopsyche piatrix	U	4
A panorpid scorpion fly	Panorpa braueri	MO-W	2
A water boatman	Sigara mathesoni	U/R	2
A winter stonefly	Allocapnia pygmaea	U/R	2
Alligator snapping turtle	Macroclemys temmincki	MO-R	2
American bittern	Botaurus lentiginosu	MO-R	4
American brook lamprey	Lampetra lamottei	MO-R	4
An aquatic beetle	Ancyronyx variegata	U	4
Bald eagle	Haliaeetus leucocephalus	FE, MO-E	4
Black-crowned night-heron	Nycticorax nycticorax	MO R	4
Blue sucker	Cycleptus elongatus	FP, MO-W	1,4
Checkered madtom	Noturus flavater	MO-W	4
Double-crested cormorant	Phalacrocorax auritus	MO-E	4
Eastern cougar	Felis concolor	FE, PEX	4
Gray bat	Myotis grisescens	FE, MO-E	1
Great blue heron	Ardea herodias		2
Grotto salamander	Typhlotriton spelaeus	MO-W	4
Indiana bat	Myotis sodalis	FE, MO-E	1
Lake chubsucker	Erimyzon sucetta	MO-R	4
Least bittern	Ixobrychus exilis	MO-W	4
Least brook lamprey	Lampetra aepyptera	MO-W	4
Little blue heron	Egretta caerulea	MO-R	4
Long-tailed weasel	Mustela frenata	MO-R	4
Mooneye	Hiodon tergisus	MO-W	4
Osprey	Pandion haliaetus	MO-E (migrant)	4
Ozark hellbender	Cryptobranchus alleganiensis	MO-W	4
Pugnose minnow	Notropis emiliae	MO-E	2
Pygmy rattlesnake	Sistrurus miliarius	MO-W	2
River otter	Lutra canadensis	MO-R	4
Salem cave crayfish	Cambarus hubrichti	U	2
Southern cavefish	Typhlichthys subterraneus	MO-W	4
Stargazing darter	Percina uranidea	MO-R	2
Western fan-shell	Cyprogenia aberti	MO-E	4
Western heel-splitter	Potamilus purpuratus	MO-E	4

Footnotes listed on next page.

[1] Specific locations of all species are contained in the files of the Winona Ranger District, Mark Twain National Forest.

[2] FE, Federal Endangered; FP, Proposed for Federal Listing; MO-E, Missouri Endangered; MO-R, Missouri Rare; MO-W, Missouri Watchlist; PEX, Possibly Extirpated; U, Status Undetermined in Missouri; U/R, Undetermined Status/Relic Population

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APPENDIX 11

A DESCRIPTION OF THE IMPLAN SYSTEM

To analyze the economic and social impacts of planned activities on National Forest lands, the Forest Service has developed a computerized system called IMPLAN. Included in the system are a data base containing economic information from which input-output (I-O) tables for areas as small as a county may be constructed, computer programs for retrieving data and building the I-O model, and a program for projecting the economic impacts of different Forest Service planning alternatives.

The data base contains a 528 x 528 national technology matrix. This matrix, which includes all 528 national industrial sectors, was developed by updating the 1972 national input-output model to 1982 using income and product accounts and associated data. The data base has estimates of economic activity and employment for each of the 528 industrial sectors for all states and counties. The economic activity estimates for each sector include final demand (personal consumption expenditures, capital formation, inventory change, government expenditures, and foreign exports), final payments to primary inputs (employee compensation, indirect business taxes, and property income), and total gross output. To maintain consistency, these estimates were made by disaggregating the national figures to the states and then distributing the state figures among the counties. This disaggregation was accomplished using a number of different data sources including as the Census of Agriculture, County Business Patterns, and reports by the Dun and Bradstreet Corporation.

After the area of analysis has been defined by the analyst, the ACCOUNT module of the IMPLAN system is used to develop a set of tables containing interindustry transactions and direct coefficients for the region. This basically involves the use of the Supply-Demand Pooling algorithm which takes the national production coefficients and applies them to the area estimates of total gross output, final demands, and final payments for each sector.

In addition to the analysis area interindustry transactions and direct coefficients tables, the Supply-Demand Pooling algorithm constructs a set of competitive and noncompetitive imports tables, as well as estimates of domestic exports. Competitive imports are purchases of outputs by industries and consumers in the analysis area from outside the area. Even though there are sectors already in the area producing the same commodity, they are not large enough to satisfy total demand. For noncompetitive imports, outputs must be purchased from outside the region, since the industry producing the output does not exist in the analysis area.

Once the ACCOUNT module has been run, it is necessary to find the outputs required to sustain a given level of final demands. The INVERT module of IMPLAN is used in this step of the process. The execution of INVERT results in the generation of several reports which give Type I and Type III multipliers for personal income, total income, value added and employment for every sector. The Type I multiplier shows the direct and indirect impacts per unit of direct impact, while the Type III multiplier shows total impact (direct, indirect, and induced) per unit of direct impact. The direct impact is the impact on the initial sector experiencing a change in final demand. Indirect impacts measure the effects on industries which provide inputs to the initial sector, while induced impacts are those which result from employees and business owners spending their income within the region.

Finally, the IMPACT program uses information from INVERT to estimate and report the effects on output, income, and employment of different final demand vectors supplied by the analyst.

Several different assumptions are made in input-output models such as IMPLAN. One assumption is that the production functions are linear in form, so to increase output by a certain percentage requires that all necessary inputs be increased by that same percentage. Potential economies of scale therefore, are not considered in the model. Also, the technology is assumed to be fixed, and the dimension of time is ignored. In spite of these somewhat limiting assumptions, input-output models are recognized as being one of the most valuable tools for analyzing economic and social impacts.

As mentioned above, the effects on output, employment, and income of different alternatives are estimated by the execution of the IMPACT module. This requires that the physical outputs from the area in question be identified and the expenditures per unit of output be determined. For Alternative A in this EIS, the outputs from the study area incorporated into the model were timber, range, wildlife, and several types of recreation activities (Table of Chapter 4 is a summary of the projected outputs for Alternative A). Forest Plan values were used to determine total per unit expenditures for the various Alternative A outputs. These expenditures were then distributed to specific industries based upon the procedures discussed in the IMPLAN Version 1.1: Analysis Guide.

Since Forest Service land management activities also affect the local economy through the purchase of goods and services, Forest Service expenditures related to the production of the physical outputs from the study area were included in the model.

For Alternatives B, C, D and E, tons of concentrate and a dollar measure of construction activity relating to the new mine(s) were added to the list of Alternative A outputs. In the Low Development Scenario,

115,000 tons of concentrate would be produced, while in the High Development Scenario, production would be eight times as great (i.e., 920,000 tons). The value per ton of concentrate was a weighted average of the value of the three individual concentrate products (lead, zinc and copper) calculated from the metal content and refined metal prices adjusted for smelter charges/deductions and transportation costs. The total cost of mine development was determined using the U.S. Bureau of Mines Cost Estimating System. An assumption was made that expenditures would be spread equally over the 4-year construction phase. Table 11A lists the expenditures per unit of output for all outputs used in the impact analysis (since IMPLAN is calibrated to the year 1982, expenditures are expressed in constant 1982 dollars).

Table 11A
EXPENDITURES PER UNIT OF OUTPUT

Output Description	Unit of Measure	Expenditures Per Unit
Timber:		
Sell Volume	MBF	$204.00
Recreation:		
Semi-Prim, Non-Motorized	RVD	$ 20.64
Semi-Prim, Motorized	RVD	$ 19.05
Roaded Natural	RVD	$ 17.66
Wildlife:		
Use	WFUD	$ 29.23
Range:		
Use	AUM	$ 24.40
Minerals:		
Concentrate Produced	Ton	$204.83
Construction Costs	Mine	$ 9.98m

Source: USDA-Forest Service, 1987

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